...neering
...rary

Engineering News-Record

Twenty-five cents, five dollars per year **February 1, 1934** McGraw-Hill Publishing Company, Inc.

Beginning a series of five papers
reporting fundamental results of

Large Retaining-Wall Tests

By Karl Terzaghi

I—Pressure of Dry Sand

OTHER ARTICLES IN THIS ISSUE:

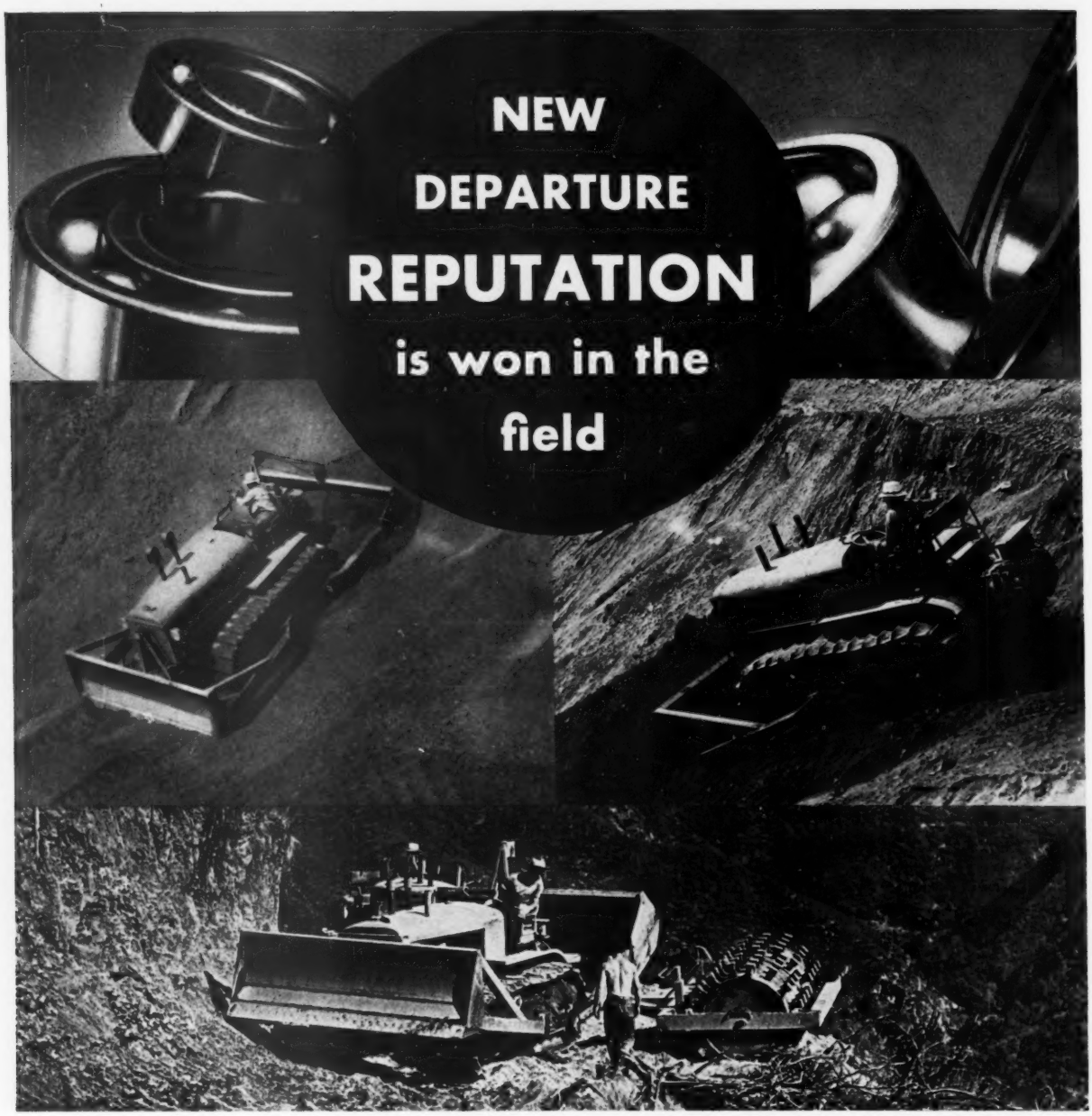
Tunnel Progress on Colorado River Aqueduct

Earthquake Resistance of Timber Floors

A Guide to Winter Concreting

Labor Rates and Materials Prices

Report of American Road Builders Convention



SOME tractors lead the life of a pet saddle-horse. Others must endure years of drudgery. Allis-Chalmers tractors are prepared for the worst — they are equipped with New Departure Ball Bearings. « « « Here are bearings forged of the finest steel, hardened clear through and carefully tempered. That makes them strong and durable. Large balls, accurate almost to perfection, reduce friction to the vanishing point. That gives them speed-ability. They give rigid support to gears and shafts, and properly sealed (as in A–C tractors), they resist wear indefinitely and greatly prolong machine life. Look for them in all your new equipment. It will pay in extra profits. » » » The New Departure Manufacturing Company, Bristol, Connecticut. Branches located at Detroit, Chicago, San Francisco, London.

2091

NEW DEPARTURE

Editorial Staff
New York
V. T. Boughton
W. G. Bowman
C. S. Hill
F. W. Herring
H. W. Richardson

ENGINEERING NEWS-RECORD

F. E. Schmitt, *Editor*

Willard Chevalier, *Publishing Director*

Editorial Staff
Chicago
W. W. De Berard
San Francisco
N. A. Bowers
J. I. Ballard

CONTENTS FOR FEBRUARY 1, 1934

VOLUME 112 *Copyright 1934, by McGraw-Hill Publishing Company, Inc.* NUMBER 5

Colorado River Aqueduct Tunnel Progress.. 131
Discharge Coefficient on Long Pipe Line..... 135
Large Retaining-Wall Tests—I..... 136
BY KARL TERZAGHI
Three Pavers Divide Work on Concrete Road 140
Earthquake Resistance of Timber Floors.... 142
BY N. B. GREEN and A. C. HORNER
A Guide to Winter Concreting..... 146
BY F. R. McMILLAN
American Road Builders Convention..... 147
Editorials 150
Current News 152
Business Side of Construction..... 158

In the News:

The United Mine Worker's, meeting at Indianapolis, will consider a resolution urging taxes on natural gas, oil and water, according to press reports, and also will vote for a 30-hour week and higher wages for themselves. Thus are logic and fairness pilloried in a bad example of inter-industry competition.

Lower Interest for federal housing loans was urged by Langdon W. Post, tenement house commissioner of New York, in an address at the National Housing Conference meeting in Washington last week. In cities where land values are high, the 30 per cent grant for labor and materials is less than a 20 per cent grant on the total cost, and Mr. Post maintains that a lower interest rate is more important than the grant. At present interest rates, the government is making money on housing loans, he charges.

A Federal Grand Jury at Ottumwa, Iowa, has brought in indictments against Lieut.-Governor Nelson G. Kraschel and Carleton D. Beh, for conspiracy to defraud the United States. The charge is that Kraschel and Beh conspired to persuade several cities to borrow the money for PWA-grant projects from Beh's investment company rather than from the federal government. The court's action would seem to be contrary to the original intent of the Recovery Act which contemplated the widest possible use of private financing.

PWA has granted a five-million-dollar loan for the Hillside Housing Corp. project in the Bronx, New York City, one of the earliest of sound housing projects to apply for government financing. Once killed by real estate opposition supported by city officials after it was granted an R.F.C. loan, the project still meets criticism. The head of a real estate board says that such housing is not needed: "It will draw tenants from existing buildings. Government funds should not be used for the construction of needless apartment houses."

Appointment of an army engineer to head up the Cook County (Chicago) CWA work in Illinois and the wholesale resignation of the Illinois Emergency Relief Commission as a CWA agency, in protest over what the commission takes as an affront to its integrity and ability, are indicative of the increasingly difficult job of handling the CWA work. Other similar administrators have been mentioned for other communities in other states.

The Federal Power Commission renews its request to Congress that it be given supervisory authortiy over the holding companies that control its licenses because they can make much of its work of no avail.

In This Issue:

What is perhaps the greatest of tunneling projects in engineering history is well under way on the Colorado River Aqueduct in the 240-mile strip of mountainous and desert country that lies between the Colorado River and the seacoast cities of Southern California. Twenty-nine individual tunnels, aggregating 92 miles in length, are involved. Some fifteen different contractors, in addition to a large day-labor organization of the Metropolitan Water District, are carrying the work forward. Interesting comparisons of construction methods will eventually be available. In this issue the progress of the tunneling operations is outlined.

A Nine-Mile, 30-in. diameter, welded-steel water line in Pennsylvania was tested recently for friction loss. The Hazen-Williams coefficient was found to have the high value of 130.8 minimum and 145.8 maximum.

The Pressure of dry sand against a model retaining wall, capable of being tilted forward and back about its lower edge and of being translated horizontally, is discussed in Dr. Terzaghi's first article on the M.I.T. tests. Even with this ideal material, the earth-pressure phenomenon was found to be quite complicated.

It is a stimulating and somewhat singular experience to read of a highly mechanized road job these days. Hoeffken Brothers, contractors, Belleville, Ill., put their concrete batches through three mixers in sequence, used finishing machines, center-joint machines, etc., on a job near Sedalia, Mo., that would be notable in the days of highest pressure. It is interesting to compare the output with that of some of the "maximum-hand-labor" jobs. The comparative costs would also be interesting—perhaps startling.

Lateral Strength of timber floors, measured by testing panels 27x40 ft., is being determined by an important investigation current in Long Beach, Calif. Results so far show the value of flooring laid diagonally with the joists, to resist shear, and also indicate the advisability of using a second layer of flooring at right angles to the joists, to resist direct bending stresses. The panel action under load was analagous to that of a simple beam, which indicates the importance of nailing and the probable significance of board length. The panels of proper design were all strong enough to resist the reaction from any commercially practicable masonry wall. Whether they will be rigid enough to give adequate lateral support to prevent wall rupture is one of the important questions still being studied.

Coming Articles:

A Review of the preceding year's work and accomplishments is always valuable and worth while. This year it assumes added importance, for few brief periods in the long history of civil engineering have produced such a kaleidoscopic group of events as did 1933. Public works and the PWA; NRA and the engineering and construction codes; the impact of social and economic planning on engineering activity—each of these has affected the life and habits of every reader of this journal. Well-known and well-qualified writers will review and evaluate these events in next week's issue. In addition, this Annual Review Number will record the statistical picture of construction during the year, will present a factual summary of design and construction achievement in each field of activity, will list the status of major construction projects in every part fo the country and will analyze the state of the art in such representative fields as research, contracting governmental affairs and engineering education.

no matter how cold the weather— it is a simple job to install these WHITE CONCRETE CURBS AND MARKERS *That STAY White!*

In winter months, installation of permanent white concrete markers and curbs can go right ahead. Precast sections of both curbs and markers are quickly and easily placed even in zero weather. Made indoors, they are simply moved to the job and set in position. Once installed, these white concrete curbs and markers are permanent, maintenance-free improvements. They never need replacement. Their low first cost is the last cost. White thru and thru, with a smooth, hard, stain-resistant surface, these easy-to-see markers and curbs *stay* white everlastingly. For complete information, write Universal Atlas Cement Co. (*Subsidiary of United States Steel Corporation*), 208 South La Salle St., Chicago.

The Massachusetts State Highway Dept. formerly used natural stone blocks for curbs, with a white cement wash, as shown above. Then it was decided to improve this by using a white cement mortar coat, troweled over the stone.

Now a third step has been taken. Precast white concrete curbs like these are shop-made, then taken to the job and set in place. Advantages: high visibility, simple methods, low first cost, *no* maintenance, installation any time.

ATLAS WHITE MARKERS AND CURBS

161

Made with Atlas White Portland Cement—Plain and Waterproofed

ENGINEERING NEWS-RECORD

New York

February 1, 1934

Tunnel Progress on the Colorado River Aqueduct

Adit and shaft approaches on this greatest of all tunneling projects are near completion and many headings are started—wide variety of equipment is in use on different sections

INVOLVING 91 miles of 15¼- and 16-ft.-diameter tunnel, the Colorado River aqueduct, which is now being built by the Metropolitan Water District of Southern California, represents the most extensive tunneling undertaking ever attempted on any engineering project. This total underground mileage is divided into 29 individual tunnels, of which the longest between portals is the 18.2-mile East Coachella tunnel being driven with the aid of four adits. The longest section to be advanced from two headings is the 8.3-mile length between shafts on the San Jacinto tunnel. The tunnels will subsequently be connected with 65 miles of lined canal, 56 miles of covered conduit and 28 miles of siphons and other pressure lines to complete the 241-mile aqueduct from the diversion dam near Parker, Ariz., on the Colorado River to the Cajalco Reservoir at the western terminal. A total static pumping lift of 1,583 ft. will be required to boost the water over several mountain ranges. From the Cajalco Reservoir a distribution system will deliver the supply to the member cities of the district. An outline of the project appeared in *Engineering News-Record*, June 16, 1932, p. 847, a progress review May 25, 1933, p. 678, and a description of the important construction of the water-supply system Jan. 4, 1934, p. 13.

On Sept. 29, 1931, the thirteen cities comprising the district voted a bond issue of $220,000,000 to finance the project. In subsequent litigation the courts upheld the validity of the bonds, ending with a favorable decision of the state supreme court rendered on June 2, 1932. The Reconstruction Finance Corporation agreed to take $40,000,000 of the bonds during 1933 and 1934, providing financing for start of work.

The route of the aqueduct lies across deserts and mountains, much of it of difficult access. Water supply, power and access roads had to be provided prior to the start of actual construction operations. The District built 172 miles of oil-surfaced highways at a cost of $1,000,000. These are primary routes only, and many miles of additional roads were built by individual tunnel contractors to reach their jobs. Over $700,000 was spent in building a water-supply system serving 200 miles of the aqueduct line. Power transmission lines built by the District include 162 miles of 66-kv. lines and 229 miles of 33-kv. lines. Most of this preliminary work was done by contract.

On Nov. 29, 1932, the first tunnel bids were opened for the San Jacinto tunnel. Failure of the low bidder, to whom contract was awarded, to furnish specified bonds resulted in delay in getting started. Subsequently this contract was rescinded, and award was made to the second low bidder on Feb. 10, 1933. This delay, coupled with outside pressure to get men to work at once, led the District to undertake considerable tunnel work on a force-account basis. Tunnels selected by the District for this work were the East Coachella, Thousand Palms No. 1 and No. 2, Wide Canyon No. 1 and No. 2, and the east portion of Seven Palms, aggregating 138,884 ft. in length. Other tunnels were rapidly placed under contract, bringing the total of contracts let by the end of 1933 to 57.8 miles of tunnel. Bids were opened Jan. 30, 1934, on all the remaining tunnels, consisting of East Eagle Mountain, for which bids have twice been rejected, and the west section of Seven Palms, Long Canyon, Blind Canyon and Morongo No. 1 and No. 2, aggregating 8.89 miles in length.

FIG. 1—EAST PORTAL of the 3½-mile Coxcomb tunnel, showing the massive rock encountered on some sections of the aqueduct line.

With completion of the preliminary activities for providing communication, water and power along the aqueduct line, the construction operations are now almost exclusively tunneling. Contracts have not been let for any of the canal and conduit sections. Tunnel driving is now in progress at all access points that will be required for work now under construction. During November 11,141 ft. of tunnel and 1,793 ft. of adits were driven for an aggregate of 33,203 ft. of tunnel and 9,640 ft. of adits up to December. No tunnel lining has been started. When the work becomes a little further advanced on all contracts and operations more or less standardized, valuable information will be available through a comparison of the various methods and operations of the many individual organizations driving concurrently the same size tunnel. For the present it is possible only to indicate the general type of tunneling procedure that has been started on the more advanced contracts and to indicate definite progress in the form of tabular information. The accompanying table indicates

the footage driven on the individual sections of tunnel.

Access highways built

To provide facilities along the 241-mile aqueduct line that extends for the eastern half of its length through a mountainous desert region the district constructed, as a preliminary to aqueduct work, roads, power and telephone lines and a water-supply system along the route. Road work has been completed with the exception of some supplemental surfacing contracts near the river, and there is now provided an excellent modern highway generally paralleling the aqueduct line from which contractors have constructed the supplemental roads to their camps. The road was essential in providing means for communication and transportation of material to the isolated construction camps. Its design and construction follows ordinary secondary highway practice with the possible exception of the lack of drainage structures.

In this desert region the numerous small draws and water courses crossed by the highway are dry the year round with the occasional exception of local desert storms, which may produce sharp, heavy local runoff. To provide facilities along the highway sufficient to handle these local floods, if and when they occur, would have necessitated structures of large size. For this reason it was considered economical to carry the road down through these desert dips without providing any structures. In case of the occasional local storms the runoff crosses the road surfacing, generally without affecting traffic. If sand and gravel is deposited, it can be quickly removed by a motor grader. Of course at infrequent intervals more severe storms may cause damage to the surfacing or may even wash out a section at the bottom of these depressions, but the repair work necessary is estimated to be much less than the cost of structures.

Field headquarters for the district are located at Banning, about 100 miles east of Los Angeles and near the San Jacinto and Coachella Valley tunnel units. A general headquarters building of single-story Spanish design has been built to house engineering offices and drafting rooms. A separate building provides garage and repair facilities for district cars. A well-equipped testing laboratory is continuing a program of research into the problems of concrete for tunnel lining and canals, which has been in progress for more than two years.

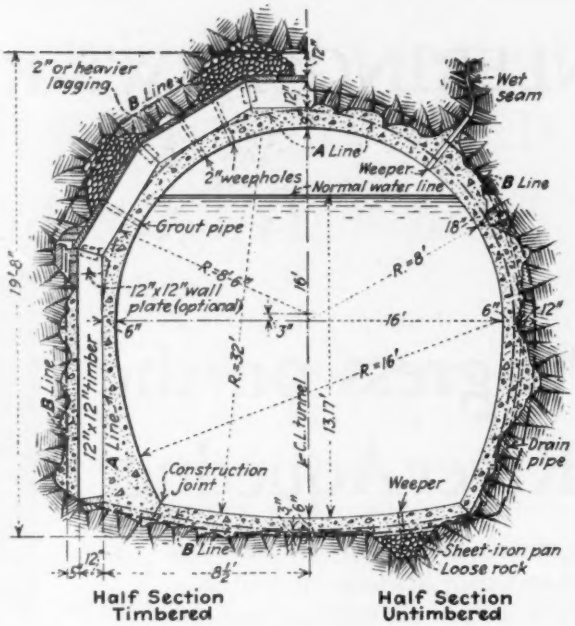


FIG. 2—HALF-SECTIONS of standard 16-ft. tunnel section for Colorado River Aqueduct. Other forms of temporary support specified are light timbering, light steel supports and gunite coating.

Buildings at the various working points along the aqueduct are in general similar to construction-camp practice. The most distinguishing feature is the incorporation of various modifications in design to provide the most efficient natural ventilation and circulation for combating the summer heat of the desert. The typical camp (Fig. 3) contains the usual dormitory buildings for the crews, mess hall, office building and shops. The most elaborate construction camp layout is the Berdoo camp where the District has established headquarters for its force-account work on the Coachella tunnels. Comfortable accommodations are provided here for the engineering force of the district on this section, and this is the location of the main hospital.

Supplies and construction equipment can be delivered by railroad at several points along the aqueduct line. In some cases the truck haul from the nearest railroad point to the tunnel location approaches 50 miles.

Access work

Coachella Adits—Access to the tunnel line has required extensive adit driving on the east Coachella tunnels under the force-account work of the District. The

PROGRESS ON COLORADO RIVER AQUEDUCT TUNNELS TO DEC. 16, 1933

Tunnel (In order from east to west)	Length, Ft.	Contractor	Contract Price	Footage Driven Dec. 16	Men in Crews Dec. 16	Remarks
Colorado River	5,640	Walsh Const. Co., Davenport, Ia.	$543,884	0	0	
Copper Basin No. 1	750	Walsh Const. Co	1,192,816	517	106	613-ft. adit driven.
Copper Basin No. 2	11,510					
Whipple Mountain	32,244	Walsh Const. Co	2,621,434	423	141	1,020-ft. adit driven.
Iron Mountain (East sect.)	39,805	Winston Bros. Co., Minneapolis	2,143,799	493	102	165-ft. shaft complete.
Iron Mountain (West sect.)	16,172	Utah Const. Co., Ogden	1,699,705	3,233	96	
Coxcomb	17,795	Winston Bros. Co	1,624,515	1,480	99	
East Eagle Mountain	9,460	Bids Jan. 30, 1934.	.....	.....	...	
West Eagle Mountain (East sect.)	26,560	Broderick & Gordon, Denver	1,435,614	0	73	1,085 ft. of 1,950-ft. adit driven.
West Eagle Mountain (West sect.)	10,629	L. E. Dixon & Bent Bros., Los Angeles	1,025,898	967	83	
Hayfield No. 1	9,677	Hunkin-Conkey Const. Co., Cleveland	814,952	0	64	320 ft. of 422-ft. adit driven.
Hayfield No. 2	5,375	Shofner & Gordon, Los Angeles	471,889	510	54	
Cottonwood	20,105	J. F. Shea Co., Inc., Portland, Ore	1,857,062	3,686	143	
Mecca Pass No. 1	325					
Mecca Pass No. 2	970	Morrison-Knudsen Co., Boise, Idaho.	575,675	732	85	No. 1 and 2 approach cuts 95% complete.
Mecca Pass No. 3	4,632					
East Coachella	96,460	Met. Water District.	.....	11,810	562	Four adits driven, totaling 6,554 ft.
Thousand Palms No. 1	15,090					
Thousand Palms No. 2	3,799					
Wide Canyon No. 1	14,330	Met. Water District.	.....	8,670	268	2,117 ft. portal cut required to open eight headings.
Wide Canyon No. 2	820					
Seven Palms (East sect.)	8,385					
Seven Palms (West sect.)	8,300	Bids Jan. 30, 1934.	.....	.....	...	
Long Canyon (East sect.)	8,300					
Long Canyon (West sect.)	6,880					
Blind Canyon	6,750	Bids Jan. 30, 1934.	.....	.....	...	
Morongo No. 1	5,510					
Morongo No. 2	1,790					
Whitewater No. 1	1,970	West Const. Co., Los Angeles.	1,051,637	1,485	78	Access cut to No. 1, 98% complete.
Whitewater No. 2	8,236					
Bernasconi	6,220	Hamilton & Gleason, Denver.	412,055	1,657	39	
Valverde	37,150	Dravo Contr. Co., Pittsburgh.	3,366,603	4,153	256	Two shafts, 226 and 208 ft., complete; third under way and fourth planned.
San Jacinto	67,415	Wenzel & Henoch, Milwaukee	7,339,100	0	154	261-ft. Cabazon shaft complete, half of 1,079-ft. cross-drift driven, 796-ft. Potrero shaft sunk 481 ft.

FIG. 3.—MOST OF THE construction camps are located in this type of rough desert country. The camp shown is at the Whipple Mountain tunnel adit.

four adits, varying from 686 ft. in length at Yellow Canyon to 2,935 ft. at Pushawalla, have now been completed and the tunnel headings turned in both directions. This work constituted the first operations of the District's program and was carried forward under emergency conditions and with temporary equipment in an effort to put men to work as rapidly as possible. This immediate unemployment-relief feature was one of the essential reasons for undertaking this section by force account. Much of the tunnel work was started before permanent equipment arrived and camps were completed. As a result, there are no outstanding developments in driving progress or methods to be reported for this adit work.

Drilling was done almost entirely from bars set up at the face for each round, advancing the full face of the 12x13-ft. adit. At the outset mucking was done by hand, and some of the hauling was done with mules prior to the arrival of equipment. This consisted of electric mucking machines for loading and 36-in.-gage storage-battery locomotives for hauling. With this type of equipment the adits were extended to the tunnel line and ended in 75-ft.-radius curves in both directions, followed by opening up of the full-size tunnel heading.

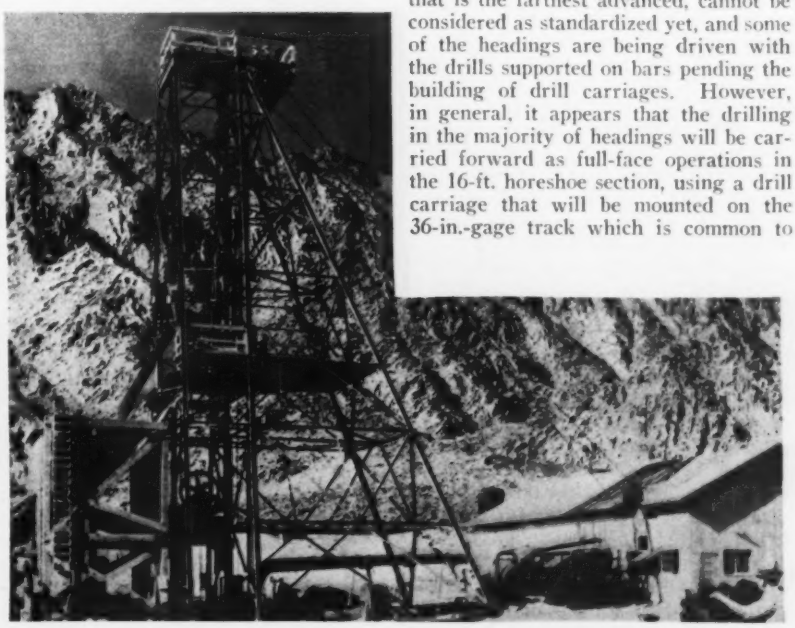
Ventilation of the various adits is taken care of by positive pressure blowers with the air carried in the metal pipe suspended on the walls or timbering. In general, it is a pressure system with the exception of a few minutes following each blast, when the direction is reversed to clear the heading of smoke and dust. Compressed air and water for drilling are carried in pipe lines on the floor. Drainage presented no problem on this work, as all of the adits were dry.

Shafts—Access to the Valverde tunnel line will be made at three, and possibly four, shafts varying in depth from 80 to 225 ft. These shafts reduce the distance between headings on this 7-mile bore to a maximum of 12,300 ft. The two deepest shafts have been completed, and driving is well started on four faces. The shafts were excavated to 12x23 ft. in section, providing for two hoists in counterbalance with a manway at one end and space for pipes at the other. These openings will be left to provide permanent access to the tunnel and have been lined with a 10-in. thickness of concrete and equipped with galvanized-steel guides.

Hoisting at the two shafts is identical and provides for raising the muck cars directly without transferring the load to skips. Tunnel hauling is done by storage-battery locomotives and 3-yd. cars that are run directly on the hoist. Arriving at the surface, these cars will be assembled into trains and hauled to the dump by gasoline locomotives.

At the San Jacinto tunnel the 260-ft. Cabazon shaft on the eastern end has been sunk and the 935-ft. cross-drift to the main tunnel line is about one-half completed. This cross-cut will permit advancing one face (west) on the longest section of tunnel on the project in addition to driving the other heading (east) to the portal, which will not be opened. The Potrero shaft necessitated about 5 miles of approach road for access, and sinking did not start until May 12.

FIG. 4—STEEL HEADFRAME at the 165-ft. shaft approach to the west (3-mile) section of the Iron Mountain tunnel.



Progress has been at the rate of about 70 ft. per month, and the estimated date of completion is April, 1934. The shaft location is on line at the only angle point in this 12.75-mile tunnel, and from it the east heading is to be started to connect with the west heading from the Cabazon shaft. The completion of the Potrero shaft will permit the start of driving both faces on this key unit in the whole program. The west heading from this shaft will also be started and will connect with a west portal heading that has already been opened.

Equipment at these two 15-ft. diameter shafts includes timber head frames and electric hoists handling 5-yd. self-dumping skips. Compressors and blowers complete the set-up. Drilling and mucking average about 5 to 6 ft. per round. Concreting operations follow to provide a 10-in. lining, as the shafts will be maintained for permanent access. In the Potrero shaft water has been encountered up to flows of 250 gal. per minute. The larger flows have been grouted off and are now giving no trouble.

Tunnel operations

Although work has not progressed to the point on either the force-account or contract operations to permit analysis of tunnel-driving methods and operations, it is of interest to note in general terms the program under way or planned for this coming work.

Drilling and Switching — Drilling procedure, even in the District work that is the farthest advanced, cannot be considered as standardized yet, and some of the headings are being driven with the drills supported on bars pending the building of drill carriages. However, in general, it appears that the drilling in the majority of headings will be carried forward as full-face operations in the 16-ft. horseshoe section, using a drill carriage that will be mounted on the 36-in.-gage track which is common to

all tunnels. These drill carriages as now functioning or programmed provide a variety of design and operations.

In the District's operations the drill-carriage design has been somewhat standardized as a tubular steel frame supporting five drills on the forward end on bars and brackets. Folding platforms on both sides, let down when the jumbo is moved, provide for the drilling crew. The drill carriage is long enough to carry the supply of drill steel, an extra drill and other miscellaneous equipment required at the face. Manifolds also carry the necessary air and water connections for the drills. This drilling carriage has no provisions for aiding in car switching during mucking operations.

Differing considerably from this drill rig, the equipment now in use and planned for two of the contract tunnels provides a 200-ft. length of double-decked jumbo supported on 10-ft.-gage track with the drill carriage at the head end. The platform of this jumbo supported by structural-steel trusses is sufficiently high for clearing of the full muck cars underneath and forms a working platform for timbering. On each end of this device is an inclined track over which empty cars are hoisted up, moved along the jumbo and let down just behind the mucking machine. This piece of equipment serves a dual purpose as both drill carriage and switching arrangement for use during mucking operations. In operation the train of empty cars is moved up to the back end of the jumbo, the ramp track is lowered by air cylinders, and the empty car is pulled up the incline and let down by a snubbing line to the mucking machine. Loaded cars are passed back on the regular track under the jumbo with both inclines in the raised position. In other words, the equipment provides for vertical switching.

An unusual piece of equipment developed on another contract is a structural-steel frame in gantry form, designed to permit the passage of cars and mucking machine, with provisions for mounting the drills at the front face. This equipment also provides for vertical switching, but in place of the inclined track arrangement electric hoists lift the empty cars above the track to clear the loaded cars leaving the mucker.

In one of the headings being driven by District forces the common type of cherry picker is used, mounted on the timbering and moved forward as required. An interesting feature of this installation is the fact that as originally built the cars proved too heavy for operation of the cherry picker with the air pressure as planned. The resourceful superintendent remedied the difficulty by hooking the water line onto the hoist, and the greater pressure was sufficient to operate the lift successfully.

In other headings temporary cross-over tracks have been installed similar to the installations made on street railroad lines to put cars on temporary sidings. These cross-over tracks are equipped with vertically feathered rails and are portable, being moved forward for economic operation of switching near the mucker.

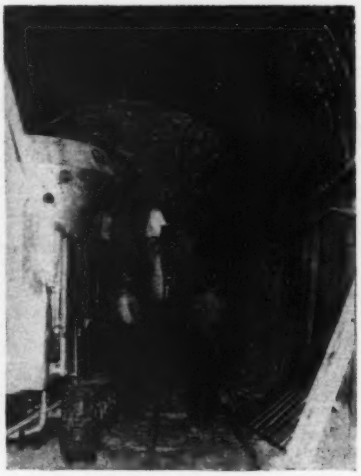


FIG. 5—STEEL LINING is being used extensively where roof support is required. Heading shown is in gravel formation at Whitewater No. 2 tunnel.

In general, it is interesting to observe that the problem of handling empty cars and switching near the mucking machine, which is a vital element of fast tunnel driving, is one of the most individual features of the various units and one in which the personal element is strong. Each superintendent is willing to prove that his arrangement is the speediest, most economical and liable to least interruption.

Loading—Indications point to most of the tunnel loading being carried on with the standard type of electrically operated mucking machine. These units are already operating in many of the headings. At the present time the exceptions to this rule are two.

A specially designed, electrically operated shovel with a 1¼-yd. bucket is operating in one of the contract tunnels loading cars at the face. With this equipment the loading is done directly into cars; a hoist located on the back end of the unit provides for switching the empty cars. In two other tunnels another specially devised loading unit is in use. This is in reality an enlarged adaptation of the mucking-machine principle with larger bucket and conveyor unit.

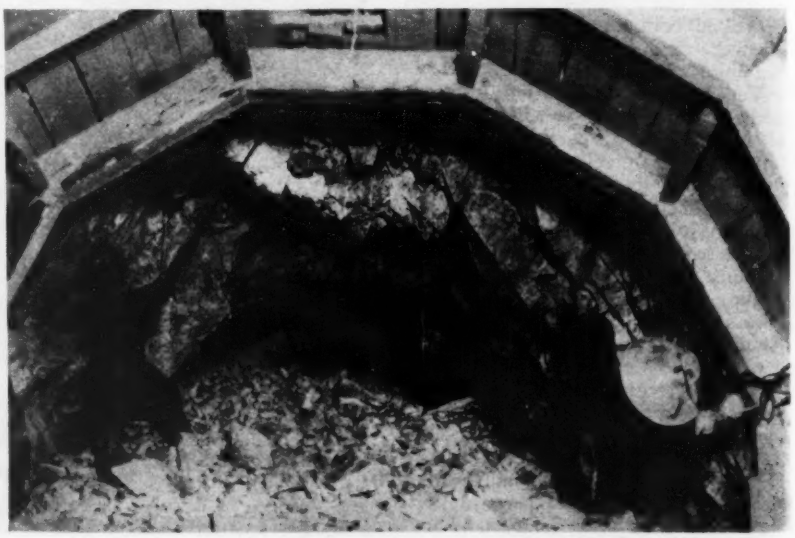
In general, plans for underground hauling include storage-battery locomotives moving trains of 3- to 5-yd. cars. The standard gage of track is 36 in. On two of the contract tunnels this type of equipment is varied by using trolley locomotives. Outside haulage is usually handled by gasoline locomotives.

Timbering

An important feature of the aqueduct tunneling operations will be the extensive use of steel supports for holding the ground. Specifications required a bid figure on timber in place and the cost of erecting steel supports. The timber was to be furnished by the contractor, and in case the engineers elected to use steel supports this material would be furnished by the District and erected by the contractor.

Steel is being used extensively in the various tunnels; in one heading 200 ft. of continuous steel support has been placed (Fig. 5). At present the steel support design consists of an arch of steel liner plates and reinforcing ribs carried on steel wall plates at the spring line, supported by steel plumb posts. So far, only a small amount of steel support has included steel liner plates on the sides. In most cases where the ground has required support below the spring-

FIG. 6—HOLING THROUGH the first tunnel; the 850-ft. Wide Canyon No. 2 on the district force-account work in the Coachella Division.



line timber, lagging has been used behind steel posts.

The general erection procedure consists of laying timber stringers along the sides of the invert to correct line and grade. On these supports are erected the steel posts, which are 4- or 6-in. H-sections with a steel bearing plate welded on both top and bottom. In some cases these posts are vertical, and in others they are battered to conform more closely with the horseshoe section of the tunnel. The lower end of the posts is spiked to the timber sill. Lateral support has not been required for any ground encountered to date.

On the top of these posts is bolted a steel-beam wall plate of either a 4- or 6-in. H-section. The arch section consists of steel liner plates with ribs spaced every third plate. The liner plates are of pressed steel, usually ¼ in. thick, although a considerable quantity of ⅜-in. plate has been used. They are of the usual type flanged on all four sides for bolting together. The ribs are 4- or 6-in. H-sections curved to the arch line and erected in two segments.

The original plan provided for the lower edge of these plates to be bolted directly to the wall plates. However, it soon developed that there was sufficient variation in the spacing to make it difficult to match these holes. A temporary expedient was the burning of the holes larger, but a more effective change was made. The improvement in erection procedure consisted of spot-welding a small channel section to the top flange of the wall plate and allowing the ends of the liner plates merely to rest in this channel without fastening. This permitted any variation in spacing. Depending on the size of the rib members, it was often necessary to burn off the extreme end of the flanges to make them fit into the channel. The entire design of this steel supporting system provides for flexibility in changing the size and weight of members according to the type of ground encountered.

The use of the steel supports has the advantage of decreasing the amount of excavation and lining concrete in addition to providing a neater and more permanent type of support. One of the more important advantages is the elimination of fire hazard in these long tunnels where the atmosphere is exceptionally dry. Considerable opposition has been met in the use of steel supports, particularly from superintendents of the old school who have used timber for years and dislike any innovation. However, several of the contractors who have tried the steel supports have noted many advantages after solving the problems involved in the changed installation.

The use of timbering, which was carried on in many of the adits before steel was available and is also being used in a good many of the contract tunnels, is in accordance with usual procedure. A five-section arch set is common. The size and spacing of the timber set varies greatly with the ground. In some sections no timbering has been necessary.

In some of the force-account headings gunite has been used extensively to coat the roof of the tunnel where timbering was not required, to prevent air slacking and provide safety against small pieces of falling rock. This provision also has the psychological effect of making a safe-looking tunnel for the men. In one case gunite applied on tar paper and mesh screen was used to cover the timbering as a fireproofing measure.

Water problems are practically nonexistent in all of the tunnels to date. In fact, the other extreme is reached and dust is a nuisance. Ventilation is carried on with the usual pressure type of blowers in most of the tunnels, using metal pipe up to near the face. In some cases a length of canvas tubing is used to extend this air duct up to the working face during drilling and mucking, removing it each time a round is fired.

Frank E. Weymouth is chief engineer and general manager of the Metropolitan Water District of Southern California. J. L. Burkholder is assistant general manager, and Julian Hinds is assistant chief engineer. James Munn is general superintendent of construction, and J. B. Bond is construction engineer with headquarters at Banning. Division engineers are: Division 1, R. C. Booth; Division 3, John Stearns; Division 4, R. B. Diemer; and Division 5, B. C. Leadbetter. The contractors are shown in the table.

High Discharge Coefficient on Long Steel Pipe Line

HYDRAULIC TESTS recently made on the 9-mile line of 30-in. lined steel pipe of the Panther Valley Water Co., at Tamaqua, Pa., show that the coefficient *C* in the Hazen-Williams formula for friction loss has a value ranging from 130.8 to 145.8. The line itself, built in 1932 to furnish water from the Still Creek Reservoir to the mining towns in the Panther Creek Valley, was described in *Engineering News-Record*, Jan. 12, 1933, p. 50. It is composed of steel plate with one electric weld longitudinally. Every third or fourth joint is made with a bolted-sleeve coupling; the remaining girth joints are electrically welded. The entire line is coated on the inside with bitumastic enamel, centrifugally applied.

In conducting the tests, Venturi meters at each end of the line were used to measure quantities of flow. The accuracy of the master meter at the reservoir end of the line is attested by the fact that for a two-month period the quantity registered was within 1 per cent of the total registration of all the meters through which water was sold. During the test, which lasted from 9:25 a.m. until 12:45 p.m. on a Sunday, the master meter at the dam recorded the passage of 1,039,000 gal.; only one consumer drew water from the line during that time, about 4,000 gal.

Pressures were measured by indicating pressure gages, one at the reservoir end, one 31,900 ft. downstream at the 16-in. connection to the Tamaqua colliery, and one at Coaldale at the far end of the line. The gages were calibrated the day before the test. Two men at each gage took readings each minute of the indicated rate of flow and pressure, and every 5 min. of the total registered flow through the meter. This registered flow, rather than the indicated flow, was used to compute pipe-line velocity.

The discharge of water through the pipe line was regulated through the openings at the Coaldale end of the line, and beyond the Venturi meter at that location. Sufficient discharge points were available so that almost any rate of flow up to 12 m.g.d. could easily be obtained and held within reasonable accuracy.

During the test no change occurred in the elevation of the water in the reservoir, as the storage at the time was about 350 m.g. and the 1 m.g. used in making the test was about equal to the amount flowing into the reservoir.

The results of the tests were as indicated in the accompanying table. At the lowest rate of flow the pressure loss as measured by the gages was so low as to make the coefficient computed at this flow of doubtful accuracy.

The test was made under the direction of J. D. Carpenter, of Gannett, Seelye and Fleming, Engineers, Inc., of Harrisburg, Pa., who had designed and installed the line in 1932. George M. Roads, Jr., superintendent, of the Panther Valley Water Co., cooperated with Mr. Carpenter in the test.

FRICTION TESTS ON TAMAQUA PIPE LINE

Rate of Flow, M.G.D.	Velocity, Ft. Per Sec.	Valve House to Tamaqua Length, 31,900 ft. Friction Loss, Ft.	*C*	Tamaqua to Coaldale Length, 18,800 ft. Friction Loss, Ft.	*C*	Valve House to Coaldale Length, 50,700 ft. Friction Loss, Ft.	*C*
2.160	0.680	2.15	123.9	0.94	145.5	3.09	130.8
4.084	1.280	5.97	134.3	3.09	144.5	9.06	139.6
8.165	2.573	19.04	144.3	10.91	147.3	29.95	145.8
9.094	3.147	28.04	143.2	16.55	143.5	44.59	143.5
12.093	3.810	39.97	143.5	22.93	145.6	62.90	144.3

LARGE RETAINING-WALL TESTS

A series of five papers reporting fundamental results

I—Pressure of Dry Sand

Tests at Massachusetts Institute of Technology furnish for first time data covering the effect on earth pressure of wall movement through the entire range up to a yield sufficient to produce slip

By Karl Terzaghi
Professor at the Technische Hochschule, Vienna, Austria

TO PROVIDE data bearing on the design of a retaining wall 170 ft. high, intended (and later built) as part of the Fifteen-Mile Falls Dam of the New England Power Association on the Connecticut River, a large earth-pressure test apparatus was built at Massachusetts Institute of Technology, as described by the author in *Engineering News-Record* of Sept. 29, 1932, p. 365. This apparatus has a bin 14x14 ft. in ground plan and 7 ft. deep, which is closed at the front by a movable retaining wall 14 ft. long and 7 ft. high so mounted as to permit of weighing the pressures against the wall; the wall also can be moved outward or inward or tilted around its lower edge.

The main purpose of constructing this apparatus was to investigate the lateral pressure of boulder clay (modified till) in different states of saturation. However, to furnish the experience required for making and for interpreting the tests with boulder clay, several tests were made with cohesionless sand. The following article deals with the results of the simplest ones of these tests, those on dry sand. The purpose of these tests was to determine how any yielding of the retaining wall affects the direction and intensity of the sand pressure.

Test material and procedure

The tests were performed with Plum Island sand (grains essentially angular, fresh quartz and feldspar with a trace of mica; effective size, 0.54 mm., uniformity coeffiicent 1.70). This material was a uniform, medium, angular sand. In the densest state its volume of voids was 38 per cent, in a loose state 46 per cent. Before use the sand was dried by steam coils on the bottom of the storage bins; due to this and to handling the sand while filling the bin it was practically dry during the tests.

The rigidity of the retaining wall and the construction of the measuring devices made it possible to determine both the intensity and the direction of the resultant earth pressure for any position of the wall up to a distance of more than 1 cm. outward or inward from the original position. The program of the tests with dry sand included the following series (Fig. 1):

Test 1—Compacted sand, wall tilting around its lower edge.

Test 2—Compacted sand, wall yielding parallel to its original position.

Test 3—Loose sand, wall tilting outward around its lower edge and then forced back again into its original position.

Test 4—Compacted sand, wall tilting around its lower edge, first advancing toward the fill, then moving outward and finally returning again to original position.

Prior to Test 1 a trial run was made for the purpose of familiarizing the operators with the testing device. For the trial run the sand was dumped into the bin and compacted in 6-in. layers with concrete tampers to a depth of 4.85 ft. (equal to about one-third the length of the wall). After the trial run, the material was excavated to an average distance of 3 ft. from the wall and the trench refilled for Test 1 by placing and compacting the sand in 6-in. layers. For Test 2 the backfill was prepared in the same way; the average width of the trench was 4 ft. For Test 3 the bin was emptied to an average distance of 8 ft. from the wall, then sand was dumped in and spread with a shovel without any attempt to compact it. For Test 4 the deposit of loose sand was entirely removed and replaced by sand compacted in 6-in. layers.

To determine the average volume of voids of the content of the bin, prismatic boxes were introduced into the bin at different stages of the filling operations. After filling had proceeded to a height of about 1 ft. above the upper rim of a box, the box was carefully excavated for the purpose of determining its volume of voids. It is obvious that these samples could not furnish more than approximate values for the average condition that prevailed in the backfill.

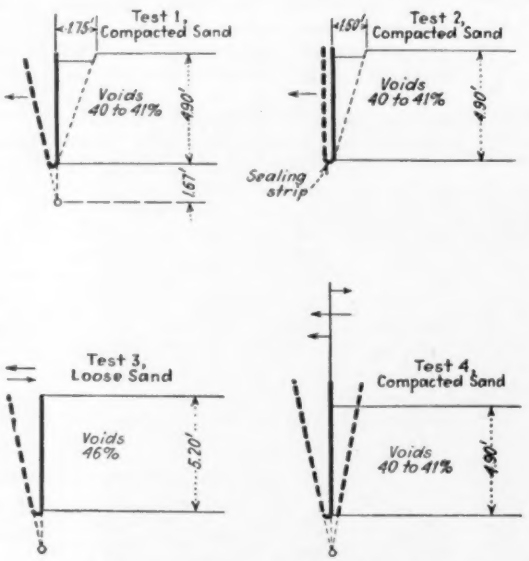


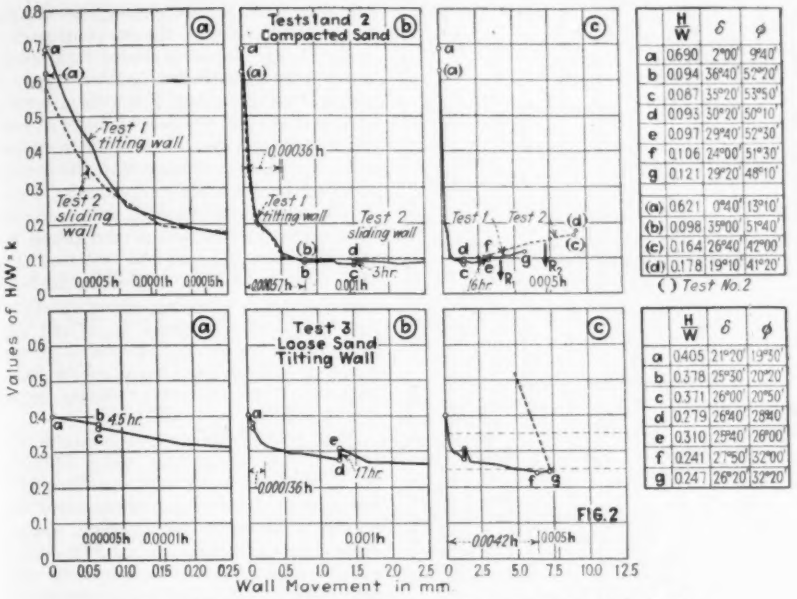
FIG. 1—FOUR CONDITIONS of sand fill and of wall movement were represented in the program of tests to determine pressure of dry sand against retaining walls.

Test results

The results of Tests 1 to 3 are shown in Figs. 2 to 5 on the following pages.

In Fig. 2, abscissas represent the wall movement in millimeters at an elevation equal to one-half of the height of the fill. Ordinates represent the hydrostatic-pressure ratio k of the earth pressure—that is, the horizontal component H of the earth pressure divided by the horizontal pressure W exerted by a liquid whose unit weight is equal to the unit weight of the backfill and whose depth is equal to the depth of the backfill.

Each test run is represented by three diagrams shown side by side. The third, (c), comprises the entire test result, with abscissas plotted to small scale, while (a) and (b) show the results of the first parts of the runs to scales fifty and five times



	H/W	δ	φ
a	0.690	2°00′	9°40′
b	0.094	36°40′	52°20′
c	0.087	35°20′	53°50′
d	0.093	30°20′	50°10′
e	0.097	29°40′	52°30′
f	0.106	24°00′	51°30′
g	0.121	29°20′	48°10′
(a)	0.621	0°40′	13°10′
(b)	0.098	35°00′	51°40′
(c)	0.164	26°40′	42°00′
(d)	0.178	19°10′	41°20′

( ) Test No. 2

	H/W	δ	φ
a	0.405	21°20′	13°30′
b	0.378	25°30′	20°20′
c	0.371	26°00′	20°50′
d	0.279	26°40′	28°40′
e	0.310	25°40′	26°00′
f	0.241	27°50′	32°00′
g	0.247	26°20′	32°20′

FIG. 2—HYDROSTATIC RATIO of dry sand as affected by yield of wall and compaction of fill.

larger. The position of the wall at which the first slip had occurred is marked in diagrams (c) by arrows and the letter *R*.

According to the diagrams of Fig. 2, there is almost no difference between the *k* curves for a wall which yields by tilting (Test 1) and a wall which yields parallel to its original position (Test 2), provided both walls are backfilled with compacted sand. On the other hand, there is no resemblance between the *k* curve for a tilting wall backfilled with compacted sand (Test 1) and a tilting wall backfilled with loose sand (Test 3).

In each test an intermission of several hours caused a marked increase of the intensity of the earth pressure in spite of the fact that the position of the wall did not change (vertical parts of the *k* curves). In Test 3, after the wall was moved out an average distance of 7 mm. (0.0045 *h*), it was forced back to its original position (dash line), which caused *k* to increase from 0.25 to 1.10. (All of increase not shown.)

Fig. 3 shows in similar arrangement the coefficient of wall friction, tan δ, plotted against the yield of the wall. The value of the coefficient of wall friction was obtained by dividing the measured vertical component of earth pressure, *V*, by the measured horizontal component *H*. An intermission of several hours almost invariably caused a decrease of the coefficient of wall friction, marked in the diagram by a thick vertical line.

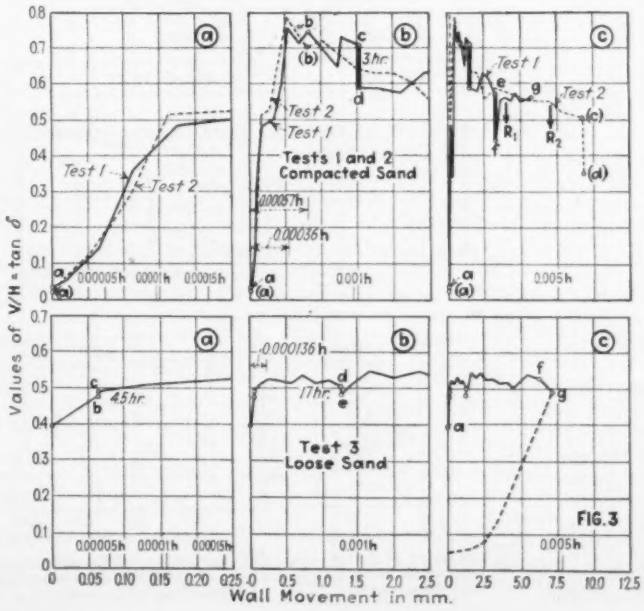
Similarly, Fig. 4 shows the relation between the height of the center of pressure (point of application of the resultant earth pressure) and the yield of the wall. According to Coulomb's wedge theory, the center of pressure for level backfill should be one-third of the depth above the base. There is a marked difference between the curves for the two walls backfilled with compacted sand, one of which yields by tilting (Test 1) and the other by moving parallel to its original position (Test 2). But in neither case did the center of pressure descend to the lower third except in an advanced state of the test, while for loose sand it remained fairly consistently somewhat below the middle third of the depth.

In Fig. 5 the diagrams (a), at the left, show the relation between sand settlement and yield of the wall. The abscissa of the point *R* gives the average distance through which the wall had yielded at the instant when the first slip occurred within the backfill. The curves located above point *R* seem to have a horizontal asymptote, those below this point a vertical asymptote. In the test with loose sand, Test 3, no slip occurred. It seemed that the occurrence of slip in the loose backfill required a larger movement of the wall than the apparatus permitted.

The diagrams (b), at the right in Fig. 5, represent cross-sections of the surface of the fill adjoining the face of the wall, for different values of wall movement. Attention is called to the conspicuous difference between the wall which yielded by tilting (Test 1) and the wall which yielded by sliding (Test 2), both walls being backfilled by compacted sand.

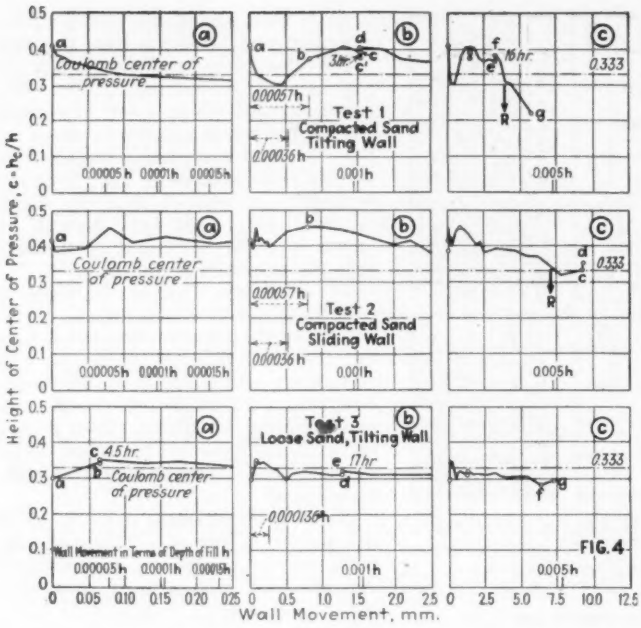
Fig. 6 is an assembly drawing of all the results of test 4. This test was made for the purpose of investigating the effect of a movement of a wall toward a compacted backfill, thus mobilizing the lateral resistance of the backfill (part of the "passive earth pressure"). Starting at point *a* in diagrams *A*, *B* and *C* of Fig. 6, the wall was forced inward an average distance of 2 mm. to point *b*, tilting around an axis located somewhat below its lower rim. During this movement the coefficient of wall friction decreased from its initial value of +0.05 and asymptotically approached a value of —0.08 against a maximum value of +0.78 in the course of the outward movement of the wall during Tests 1 and 2 (Fig. 3). On reversal of the wall movement (diagram *C* of Fig. 6, branch *b c g*), the coefficient of wall friction first of all decreased to a minimum of —0.19, then

FIG. 3—WALL FRICTION of dry sand in relation to yield of wall and compaction of fill.



	V/H = tan δ
a	0.035
b	0.745
c	0.708
d	0.586
e	0.571
f	0.444
g	0.560
(a)	0.012
(b)	0.700
(c)	0.501
(d)	0.348

	V/H = tan δ
a	0.390
b	0.476
c	0.488
d	0.501
e	0.480
f	0.527
g	0.493


Height of Center of Pressure, c = hc/h
Coulomb center of pressure
Test 1 Compacted Sand Tilting Wall
Test 2 Compacted Sand Sliding Wall
Test 3 Loose Sand, Tilting Wall
Wall Movement in Terms of Depth of Fill h
Wall Movement, mm.

	$\frac{h_c}{h}$
a	0.410
b	0.375
c	0.397
d	0.404
e	0.365
f	0.385
g	0.221

	$\frac{h_c}{h}$
a	0.416
b	0.453
c	0.335
d	0.355

	$\frac{h_c}{h}$
a	
b	0.344
c	0.350
d	0.313
e	0.322
f	0.288
g	0.298

FIG. 4—HEIGHT of center of pressure of dry sand in relation to yield of wall and compaction of fill.

increased, became zero at f, when the value of the hydrostatic pressure ratio $k = H/W$ had dropped to 0.30, and finally aproached a maximum of +0.63 at point g.

Discussion of the test results

The most striking fact disclosed by the experiments concerns the important effect of the density of the backfill on the pressure phenomena.

With compacted sand backfill, a movement of the wall over an insignificant distance (equal to one-ten-thousandth of the depth of the backfill) decreases the hydrostatic pressure ratio k down to 0.20 or increases it up to 1.00, depending on the direction of the movement. With a loose sand backfill a like movement of the wall changes the value of k merely between the limits of 0.3 and 0.5. This contrast is indicated by Fig. 7. For the compacted backfill the value k corresponding to the initial position of the wall undoubtedly depends to a considerable extent on the method of compacting. According to the results of investigations carried out independently of the earth-pressure tests, it may have any value between about 0.35 and 0.7, but knowledge of the exact figure is without any practical importance because an insignificant outward movement of the wall reduces the figure to about 0.20, irrespective of the initial value. For loose backfill the initial value of k is approximately 0.40.

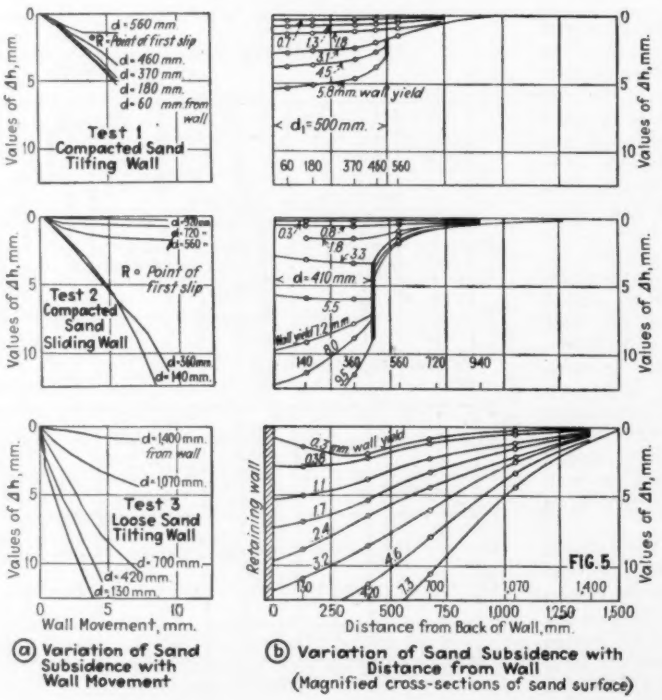
In the compacted backfill, slip occurred after the wall had moved through an average distance of 0.0027 h for tilting and 0.005 h for sliding movement. On the other hand, the movement that reduced the lateral pressure to a minimum was independent of the type of movement, about 0.0007 h (Fig. 2). To produce a slip in loose backfill, a wall movement of more than 0.008 h seems to be required; during this movement the pressure steadily decreases.

For compacted backfill, prior to the first slip, the position of the center of the pressure depends on whether the wall tilts or whether it slides. In both cases it is considerably above one-third the height of the backfill. When slip occurs, the center of pressure moves down to the middle third. For loose backfills it consistently remains at or slightly below the middle third.

The quoted differences between the behavior of dense and loose backfills are associated with corresponding differences in the changes of the structure of the sand within the sliding wedge. Based on the data of Fig. 5 we were able to compute the change of the volume of the sand contained in the wedge for a 5-mm. yield of the wall. The results in per cent of original volume are: Test 1, compacted backfill, tilting wall, 1.2 per cent expansion; Test 2, compacted backfill, sliding wall, 1.2 per cent expansion; Test 3, loose backfill, tilting wall, 0.45 per cent contraction.

A second group of interesting facts concerns the changes of the wall friction which are associated with the movement of the wall and with an intermission at stationary position of the wall. For compacted backfill the initial value of the wall friction is almost zero; a slight outward movement of the wall is sufficient to bring the coefficient of wall friction up to a maximum, but further movement causes the friction to decrease and to approach the value that corresponds to loose sand. For loose backfill a slight outward movement of the wall brings the wall friction up to an almost constant value.

FIG. 5—SAND SETTLEMENT in dry sand tests as affected by yield of wall and compaction of fill.


Values of Δh, mm.
Test 1 Compacted Sand Tilting Wall
Test 2 Compacted Sand Sliding Wall
Test 3 Loose Sand Tilting Wall
Wall Movement, mm.
Retaining wall
Distance from Back of Wall, mm.

(a) Variation of Sand Subsidence with Wall Movement

(b) Variation of Sand Subsidence with Distance from Wall (Magnified cross-sections of sand surface)

Internal friction of sand

Finally, the data shown in Figs. 2 and 6 were used for an indirect determination of the angle of internal friction at the various stages of the movement of the wall. Previous experimental investigations by Müller-Breslau, Jacob Feld and many others have conclusively demonstrated that the earth-pressure theory of Coulomb reasonably agrees with reality as far as the magnitude of the lateral pressure is con-

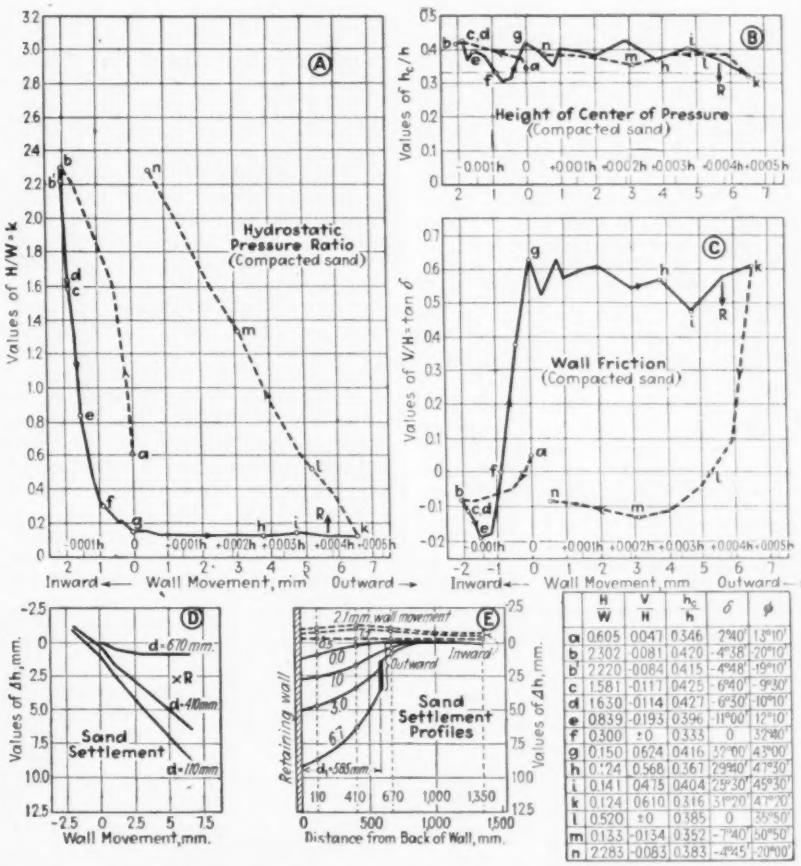
cerned. Considering the approximate character of related computations, the fact that the slip surface is slightly curved rather than plane may be neglected. Hence the computations of the author were based on the well-known formula of Coulomb. Let h be the depth of the backfill; s the unit weight of the backfill; ϕ the angle of internal friction; H the horizontal component of the pressure; V the vertical component of the pressure, and $\tan \delta = \frac{V}{H}$ the tangent of the angle of wall friction. The horizontal component H of the lateral pressure acting against the back of a vertical wall is, according to Coulomb's theory,

$$H = \tfrac{1}{2} s h^2 \left\{ \frac{\cos \phi}{1 + \sqrt{\sin \varphi (\sin \varphi \cos \varphi \tan \delta)}} \right\}^2$$

All the quantities of this formula are known from direct observation made during the test except ϕ, the angle of internal friction. Hence it was possible to compute the value ϕ for different stages of each test run. The results are shown in tables next to the diagrams in Figs. 2 and 6, together with the corresponding values of the angle of wall friction, δ. The tables disclose the following facts:

For compacted backfill the angle of internal friction assumes a temporary maximum of about 54 deg. prior to the first slip and decreases with further outward movement. This is obviously due to a progressive disintegration of the structure of the sand associated with the expansion mentioned before. A similar disturbing effect was apparently produced in Test 4 by starting the test with a movement of the wall toward the backfill. Therefore those parts of the diagrams in Fig. 6 that correspond to the outward movement of the wall have a character intermediate between the diagrams for dense and for loose sand, and the angle of internal friction never exceeded a value of 47 deg. For loose backfill the value of the angle consistently increased, due to progressive stabilization of the sand contained within the wedge, with a tendency to approach the "angle of repose" of 34 deg.

In connection with the preceding analysis it seemed interesting to compare the theoretical and the observed distance between the wall and the upper rim of the sliding surface. The computation was made by means of Coulomb's theory, based on the values of ϕ and δ corresponding to the stage at which the slip occurred. The results are shown in the accompanying table.



	H/W	V/H	hc/h	δ	φ
a	0.605	0.047	0.346	2°40'	13°10'
b	2.302	-0.081	0.420	-4°38'	20°10'
b'	2.220	-0.084	0.415	-4°48'	19°10'
c	1.581	-0.111	0.425	-6°40'	9°30'
d	1.630	-0.114	0.427	-6°30'	10°10'
e	0.839	-0.193	0.396	-11°00'	12°10'
f	0.300	±0	0.333	0	32°40'
g	0.150	0.624	0.416	32°00'	43°00'
h	0.124	0.568	0.367	29°40'	41°30'
i	0.141	0.475	0.404	25°30'	45°30'
k	0.124	0.610	0.316	31°20'	47°20'
l	0.520	±0	0.385	0	35°50'
m	0.133	-0.134	0.352	-7°40'	50°50'
n	2.283	-0.083	0.383	-4°45'	20°00'

FIG. 6—WALL-PRESSURE EFFECTS of moving wall toward backfill and then reversing the movement; compacted sand.

For Tests 1 and 4 the agreement is very good, which indicates that the theoretical assumptions for slip in cohesionless material were nearly fulfilled. For Test 2 the slip plane intersected the surface of the fill at a considerably smaller distance than Coulomb's theory would lead us to expect. The discrepancy is not surprising, because the wall yielded parallel to its original position. In this type of wall movement the ratio between the movement of the wall and the corresponding width of the wedge increased from the top of the wall toward the bottom. The excessive expansion and subsidence within the lower part of the wedge caused arching in the upper part, and the slip occurred under abnormal conditions. This interpretation is substantiated by the abnormal movement of the center of pressure in Test 2 (see Fig. 4).

A conspicuous feature of all the test results appears in the fact that an intermission when the wall was stationary almost invariably caused a decrease of the coefficient of wall friction, an increase of the hydrostatic-pressure ratio k, and in general a slight rise of the center of the pressure. Similar facts had already been noticed by Jacob Feld during his own earth-pressure tests. They represent a phenomenon that is associated with any deformation of a body of sand. As an example, the results of an older experiment of the author are recalled. A layer of sand was placed in a ring and compressed by the application of a uniformly distributed surface pressure p. After the pressure was raised to p_1, the corresponding compression was kept constant for a certain period; during this intermission, the pressure which was required to keep the compression constant decreased at first rapidly, then slowly, and finally assumed a constant value p_2.

From these observations the author concluded that the stress required to *produce* a definite state of strain in the sand is invariably greater than required to *maintain* this state. Or, if a definite state of strain is established in a body of sand, the stresses decrease during the first few hours and gradually assume their final values. During these first

TOP THICKNESS OF WEDGE OF SLIP

	Computed, Ft.	Observed, Ft.	Ratio Observed to Computed
Test 1	1.80	1.75	0.98
Test 2	2.30	1.50	0.65
Test 3	3.40	.....	.....
Test 4	2.04	1.92	0.94

Note: The computed figure for Test 3 is added merely for comparison, in spite of the fact that during the test the wall did not move far enough to permit the occurence of a slip. It is based on the assumption that $\phi = 34$ deg. and $\tan \delta = 0.50$.

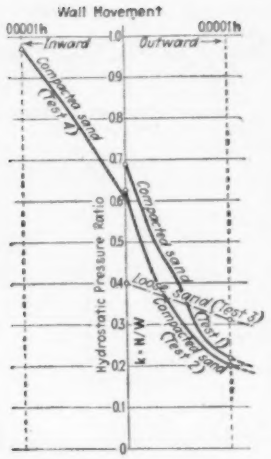


FIG. 7—CHANGE of hydrostatic ratio with movement of wall; compacted and loose backfill compared.

hours it seems that the grains slip slightly and turn into new positions, so that the forces required to keep them in this position decrease. The test results shown in Figs. 2 and 3 disclose the same fundamental property of the sand. The lateral pressure ratio $k = H/W$ depends on the intensity of the frictional stresses that act within the wedge, and the greater these stresses the smaller is the corresponding value of k. During an intermission the state of strain of the backfill remains unchanged. Hence the frictional stresses that act within the backfill and along the wall decrease, which causes an increase of the lateral pressure ratio. The gradual adjustment of the grains produces a slight subsidence of the sand within the wedge-shaped zone. Subsidence of a mass of sand inclosed between a rough wall and the stationary part of the backfill causes incipient arching, which in turn produces a slight upward movement of the center of pressure.

Conclusions on dry sand

The tests here reported furnish for the first time a set of data covering the effect of the wall movement on the earth pressure over the entire range between the original position of the wall and the yield required to produce slip. They lead to the following conclusions:

1. A striking difference exists between the behavior of dense and of loose backfill.

2. For compacted backfill the hydrostatic pressure ratio k corresponding to the pressure acting on the wall in its original position may have any value between 0.35 and 0.7, depending on how the fill was made. Inward movement of the wall through a distance of about 0.001 h (one-thousandth of the depth of the backfill) increases k up to values of 2.0 to 2.5, while outward movement of the same amount leads to the smallest values k can assume (about 0.1). Any further outward movement again causes an increase of the lateral pressure.

3. For compacted backfill the angle of internal friction assumes a well-defined maximum after the wall has yielded through an average distance of about 0.0007 h. If the wall yields further, the angle of internal friction increases again and approaches the maximum value for the loose backfill.

4. The coefficient of wall friction with dense backfill is extremely variable. If the wall moves inward toward the fill, the wall friction remains negligible. During outward movement the wall friction first assumes a maximum, then it gradually decreases toward the value that corresponds to the coefficient of wall friction for loose backfill.

5. For loose backfill, prior to any movement of the wall, the hydrostatic pressure ratio is about 0.4. Movement of the wall inward toward the fill through a distance of 0.001 h raises the value of k up to less than unity. On the other hand, outward movement decreases the lateral pressure until, after a movement through a distance of more than 0.008 h, slip occurs. At this point the hydrostatic pressure ratio assumes the Coulomb value approximately corresponding to the angle of repose. For the entire range of the movement, the coefficient of wall friction remains practically constant.

6. For both dense and loose backfill an intermission in the process of outward movement of the wall causes a slight decrease in wall friction, an increase in the value k, and in most cases a slight upward movement of the point of application of the resultant pressure.

Hence, in spite of the fact that the tests were made under the simplest conceivable conditions (dry sand, no movement of the wall in a vertical sense, etc.), the earth-pressure phenomenon was found to be more complicated than it is generally assumed to be.

Acknowledgments

These tests and those to be described in the following four papers were made in partial fulfillment of a cooperative agreement between the New Hampshire Public Service Commission, the New England Power Construction Co. and the Massachusetts Institute of Technology, the author acting as consulting engineer to the Public Service Commission. The tests were executed in the spring and summer of 1929 by G. A. Orrok, Jr., and R. G. Stafford, engineers of the New England Power Construction Co., under the supervision of the author. Their success was essentially due to the skill and initiative of these gentlemen.

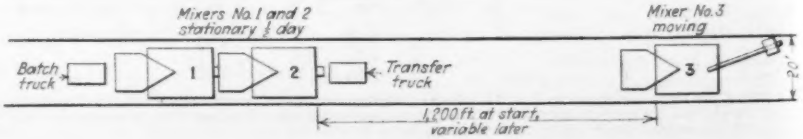
Three Pavers Divide Mixing on Concrete Road Work

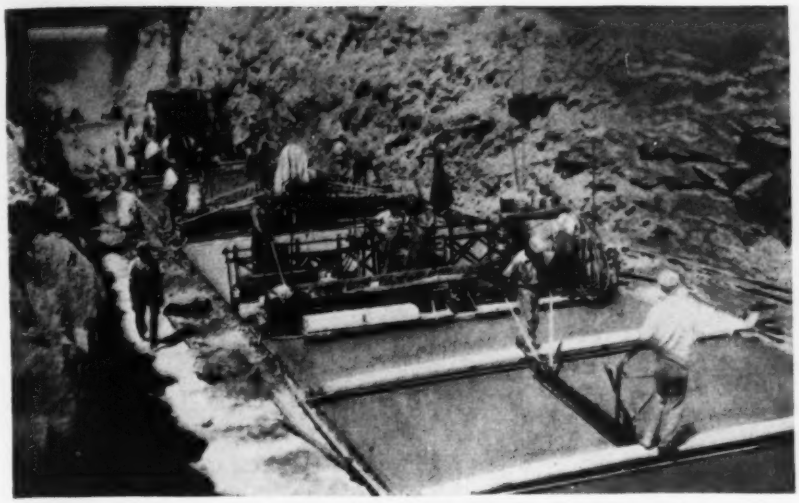
Two pavers in tandem, each mixing 28 seconds, deliver concrete to truck that feeds third paver mixing 4 seconds which places concrete in slab

USING three paving mixers, two as a central mixing unit shifted at intervals and one as a final mixing and placing unit moving with the progress of the slab, something of a concrete paving record was made in building the main trunk road running east about 27⅓ miles from Sedalia, Mo. The work included about 140,000 cu.yd. of excavation and 329,000 sq.yd. of paving. Paving was begun May 5 and was completed Sept. 14. In this period 324,928½ sq.yd. of 20-ft., 9:7:9-in., mesh-reinforced, standard slab with lip curb, and 4292½ sq.yd. of widening were concreted in 996 hours worked. Rain, mud and plant shifts in the same period accounted for 724 working hours' delays.

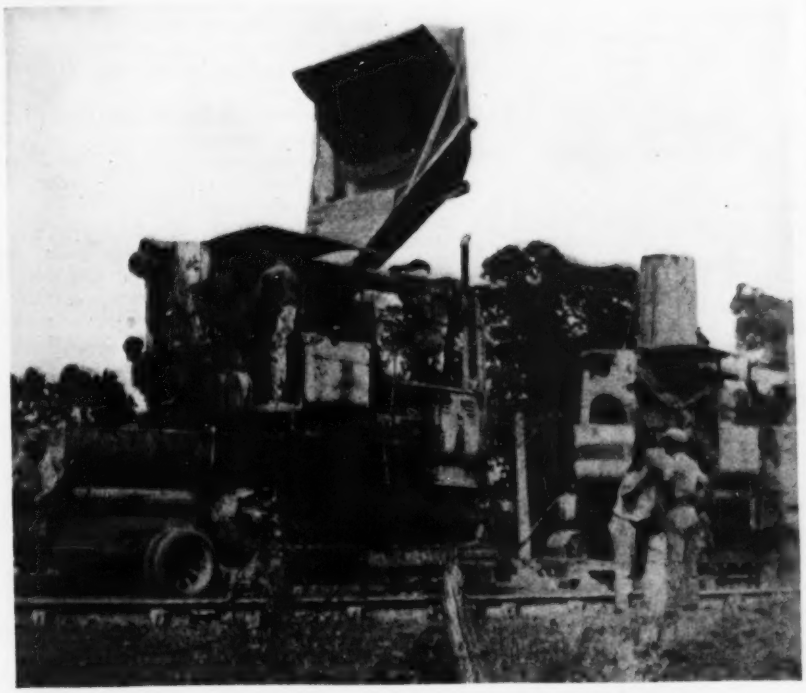
The contractor provided an unusual amount of equipment. Materials were stored at three points along the road, in each case in three stock piles of coarse aggregate, fine aggregate and sand. Two cranes and weight-proportioning plants were set up, one being shifted to the third materials-storage location when the need arose. Trucks carried the proportioned batches to the mixing plant on the grade. This plant, as indicated by the illustrations, was very complete. Besides the three mixers, arranged as is outlined below, there was a mesh strike-off, finishing

ARRANGEMENT of three paving mixers for installment mixing on Missouri concrete road.





MESH STRIKE-OFF, finishing machine, center-joint machine and longitudinal float follow three-mixer plant.



CENTRAL MIXING UNIT of two pavers on sleds mixed batch 28 sec. in each mixer and delivered to truck feeding third paving mixer.

machine, center-joint machine and longitudinal float. Equipment for preparing the subgrade and grading for forms was correspondingly complete. The unique feature of the paving plant was the three-mixer arrangement shown in the accompanying diagram.

As indicated, trucks delivered the proportioned batches to mixer 1, which began the mixing and delivered to mixer 2, which continued it; mixer 2 discharged into trucks that carried the partly mixed batch to mixer 3, which finished the mixing and distributed the concrete to the slab in the usual manner. A 1-min. mix was required, and mixers 1 and 2 each mixed 28 sec.; mixer 3 mixed for 4 sec. and placed the concrete. The operating procedure was as follows: mixers 1 and 2, mounted on timber sleds in fixed position and close enough for No. 1 to discharge to No. 2, were set up about 1,200 ft. ahead of the beginning of the new slab. This 1,200 ft. was assumed to be about half a day's slab construction. As mixer 3, building slab, closed up the 1,200-ft. gap. mixers 1 and 2 were run off the sleds and, pulling their sleds with them, were moved ahead 1,200 ft. These moves were planned to be made at night and at noon and took about 30 min. each.

The performance figures as given by C. E. Kasler, assistant division engineer in charge of construction, are as follows: The highest day's run was on June 29, on which day the contractor poured 2,357 lin.ft. in 14¼ hours, or an average of 163 ft. per hour. The highest week's run was from July 9 to July 15, during which week the crew poured 13,389 lin.ft. in 87½ hours, or an average of 153 ft. per hour. The highest run for any period, July 29 to Aug. 6, was 26,272 lin.ft. in 174 hours, or an average of 151 ft. per hour. For the entire combination the crew poured the 144,430 lin.ft. (324,928.5 sq.yd.) of pavement in 996 working hours, or an average of 145 lin.ft. per hour, during which period the contractor also poured 4,292.6 sq.yd. of widening.

As indicated before, except for the usual mixer combination, paving followed familiar procedure but with exceptionally complete equipment. The pavement was cured the first day with wet burlap, and calcium chloride was applied the second day. The average forces used each day by the paving crew consisted of 4 foremen and 125 men.

The contractors were Hoeffken Brothers, Belleville, Ill., with Al Hoeffken in general charge. The work was done under the direction of the Missouri state highway department, of which T. H. Cutler is chief engineer. S. M. Rudder was division engineer, and E. B. Gordon and C. E. Kasler division construction engineers.

Railway Lines Near Warsaw to Be Electrified

The Metropolitan Vickers Electrica Export Company, Manchester, England, and the English Electric Co., Ltd., have secured a £2,000,000 contract to electrify the Central Junction Station at Warsaw and the three lines proceeding from it toward Berlin, Danzig, and Moscow, respectively, to the extent of 50 km. in each direction.

The electrification scheme is in part complementary to the construction of a tunnel under the Vistula. Through trains from Berlin to Moscow will save an hour's time by use of the tunnel.

The official contract, which has been signed in London, provides for the supply and erection of extensive railway material, comprising locomotives, motor coaches, overhead-line equipment and substation plant, and includes the necessary finance for certain civil engineering work associated with this electrification. The work is expected to occupy three or four years.

It is expected that this contract will be followed by others for electro-technical works, probably including the extension of the central power station in the Warsaw area.

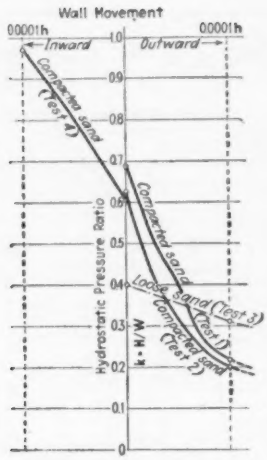


FIG. 7—CHANGE of hydrostatic ratio with movement of wall; compacted and loose backfill compared.

hours it seems that the grains slip slightly and turn into new positions, so that the forces required to keep them in this position decrease. The test results shown in Figs. 2 and 3 disclose the same fundamental property of the sand. The lateral pressure ratio $k = H/W$ depends on the intensity of the frictional stresses that act within the wedge, and the greater these stresses the smaller is the corresponding value of k. During an intermission the state of strain of the backfill remains unchanged. Hence the frictional stresses that act within the backfill and along the wall decrease, which causes an increase of the lateral pressure ratio. The gradual adjustment of the grains produces a slight subsidence of the sand within the wedge-shaped zone. Subsidence of a mass of sand inclosed between a rough wall and the stationary part of the backfill causes incipient arching, which in turn produces a slight upward movement of the center of pressure.

Conclusions on dry sand

The tests here reported furnish for the first time a set of data covering the effect of the wall movement on the earth pressure over the entire range between the original position of the wall and the yield required to produce slip. They lead to the following conclusions:

1. A striking difference exists between the behavior of dense and of loose backfill.

2. For compacted backfill the hydrostatic pressure ratio k corresponding to the pressure acting on the wall in its original position may have any value between 0.35 and 0.7, depending on how the fill was made. Inward movement of the wall through a distance of about 0.001 h (one-thousandth of the depth of the backfill) increases k up to values of 2.0 to 2.5, while outward movement of the same amount leads to the smallest values k can assume (about 0.1). Any further outward movement again causes an increase of the lateral pressure.

3. For compacted backfill the angle of internal friction assumes a well-defined maximum after the wall has yielded through an average distance of about 0.0007 h. If the wall yields further, the angle of internal friction increases again and approaches the maximum value for the loose backfill.

4. The coefficient of wall friction with dense backfill is extremely variable. If the wall moves inward toward the fill, the wall friction remains negligible. During outward movement the wall friction first assumes a maximum, then it gradually decreases toward the value that corresponds to the coefficient of wall friction for loose backfill.

5. For loose backfill, prior to any movement of the wall, the hydrostatic pressure ratio is about 0.4. Movement of the wall inward toward the fill through a distance of 0.001 h raises the value of k up to less than unity. On the other hand, outward movement decreases the lateral pressure until, after a movement through a distance of more than 0.008 h, slip occurs. At this point the hydrostatic pressure ratio assumes the Coulomb value approximately corresponding to the angle of repose. For the entire range of the movement, the coefficient of wall friction remains practically constant.

6. For both dense and loose backfill an intermission in the process of outward movement of the wall causes a slight decrease in wall friction, an increase in the value k, and in most cases a slight upward movement of the point of application of the resultant pressure.

Hence, in spite of the fact that the tests were made under the simplest conceivable conditions (dry sand, no movement of the wall in a vertical sense, etc.), the earth-pressure phenomenon was found to be more complicated than it is generally assumed to be.

Acknowledgments

These tests and those to be described in the following four papers were made in partial fulfillment of a cooperative agreement between the New Hampshire Public Service Commission, the New England Power Construction Co. and the Massachusetts Institute of Technology, the author acting as consulting engineer to the Public Service Commission. The tests were executed in the spring and summer of 1929 by G. A. Orrok, Jr., and R. G. Stafford, engineers of the New England Power Construction Co., under the supervision of the author. Their success was essentially due to the skill and initiative of these gentlemen.

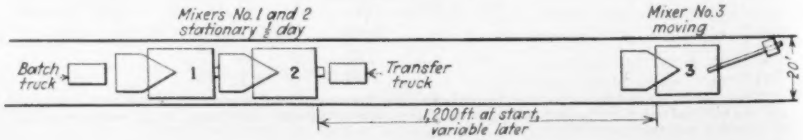
Three Pavers Divide Mixing on Concrete Road Work

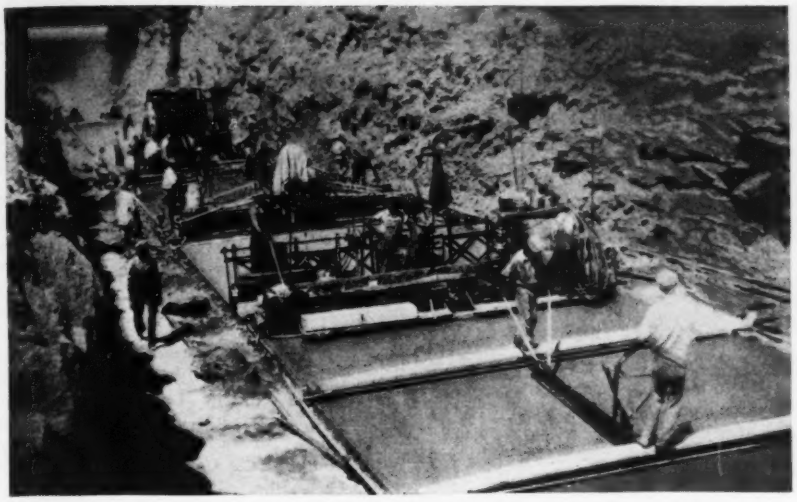
Two pavers in tandem, each mixing 28 seconds, deliver concrete to truck that feeds third paver mixing 4 seconds which places concrete in slab

USING three paving mixers, two as a central mixing unit shifted at intervals and one as a final mixing and placing unit moving with the progress of the slab, something of a concrete paving record was made in building the main trunk road running east about 27⅓ miles from Sedalia, Mo. The work included about 140,000 cu.yd. of excavation and 329,000 sq.yd. of paving. Paving was begun May 5 and was completed Sept. 14. In this period 324,928½ sq.yd. of 20-ft., 9:7:9-in., mesh-reinforced, standard slab with lip curb, and 4292½ sq.yd. of widening were concreted in 996 hours worked. Rain, mud and plant shifts in the same period accounted for 724 working hours' delays.

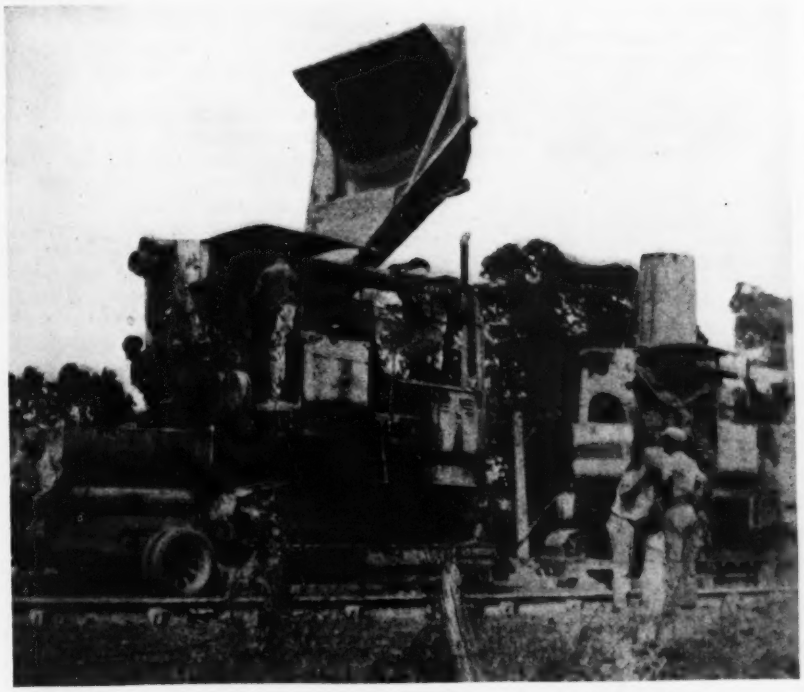
The contractor provided an unusual amount of equipment. Materials were stored at three points along the road, in each case in three stock piles of coarse aggregate, fine aggregate and sand. Two cranes and weight-proportioning plants were set up, one being shifted to the third materials-storage location when the need arose. Trucks carried the proportioned batches to the mixing plant on the grade. This plant, as indicated by the illustrations, was very complete. Besides the three mixers, arranged as is outlined below, there was a mesh strike-off, finishing

ARRANGEMENT of three paving mixers for installment mixing on Missouri concrete road.





MESH STRIKE-OFF, finishing machine, center-joint machine and longitudinal float follow three-mixer plant.



CENTRAL MIXING UNIT of two pavers on sleds mixed batch 28 sec. in each mixer and delivered to truck feeding third paving mixer.

machine, center-joint machine and longitudinal float. Equipment for preparing the subgrade and grading for forms was correspondingly complete. The unique feature of the paving plant was the three-mixer arrangement shown in the accompanying diagram.

As indicated, trucks delivered the proportioned batches to mixer 1, which began the mixing and delivered to mixer 2, which continued it; mixer 2 discharged into trucks that carried the partly mixed batch to mixer 3, which finished the mixing and distributed the concrete to the slab in the usual manner. A 1-min. mix was required, and mixers 1 and 2 each mixed 28 sec.; mixer 3 mixed for 4 sec. and placed the concrete. The operating procedure was as follows: mixers 1 and 2, mounted on timber sleds in fixed position and close enough for No. 1 to discharge to No. 2, were set up about 1,200 ft. ahead of the beginning of the new slab. This 1,200 ft. was assumed to be about half a day's slab construction. As mixer 3, building slab, closed up the 1,200-ft. gap. mixers 1 and 2 were run off the sleds and, pulling their sleds with them, were moved ahead 1,200 ft. These moves were planned to be made at night and at noon and took about 30 min. each.

The performance figures as given by C. E. Kasler, assistant division engineer in charge of construction, are as follows: The highest day's run was on June 29, on which day the contractor poured 2,357 lin.ft. in 14¼ hours, or an average of 163 ft. per hour. The highest week's run was from July 9 to July 15, during which week the crew poured 13,389 lin.ft. in 87½ hours, or an average of 153 ft. per hour. The highest run for any period, July 29 to Aug. 6, was 26,272 lin.ft. in 174 hours, or an average of 151 ft. per hour. For the entire combination the crew poured the 144,430 lin.ft. (324,928.5 sq.yd.) of pavement in 996 working hours, or an average of 145 lin.ft. per hour, during which period the contractor also poured 4,292.6 sq.yd. of widening.

As indicated before, except for the usual mixer combination, paving followed familiar procedure but with exceptionally complete equipment. The pavement was cured the first day with wet burlap, and calcium chloride was applied the second day. The average forces used each day by the paving crew consisted of 4 foremen and 125 men.

The contractors were Hoeffken Brothers, Belleville, Ill., with Al Hoeffken in general charge. The work was done under the direction of the Missouri state highway department, of which T. H. Cutler is chief engineer. S. M. Rudder was division engineer, and E. B. Gordon and C. E. Kasler division construction engineers.

Railway Lines Near Warsaw to Be Electrified

The Metropolitan Vickers Electrica Export Company, Manchester, England, and the English Electric Co., Ltd., have secured a £2,000,000 contract to electrify the Central Junction Station at Warsaw and the three lines proceeding from it toward Berlin, Danzig, and Moscow, respectively, to the extent of 50 km. in each direction.

The electrification scheme is in part complementary to the construction of a tunnel under the Vistula. Through trains from Berlin to Moscow will save an hour's time by use of the tunnel.

The official contract, which has been signed in London, provides for the supply and erection of extensive railway material, comprising locomotives, motor coaches, overhead-line equipment and substation plant, and includes the necessary finance for certain civil engineering work associated with this electrification. The work is expected to occupy three or four years.

It is expected that this contract will be followed by others for electro-technical works, probably including the extension of the central power station in the Warsaw area.

Earthquake Resistance of Timber Floors

Report of first part of a test program designed to develop facts about the range of earthquake resistance possessed by various combinations of wood floors or roofs and their connections to brick, tile or concrete walls

By N. B. Green and A. C. Horner
Consulting Engineers, San Francisco, Calif.

IN THE TIME that has elapsed since the Southern California earthquake of March 10, 1933, many theories as to the action of the principal structural materials—brick, wood, steel and concrete — have been discussed, and many facts have been cited in support of such theories. Actually, however, there exists a surprisingly small amount of fundamental technical information as to the behavior of structural assemblies of these materials under earthquake or other lateral loads.

State laws passed shortly after the March 10 earthquake require that all school buildings hereafter repaired (at a cost exceeding $1,000) or erected in California shall conform to the rules and regulations of the state division of architecture, which on April 10, 1933, adopted temporary regulation No. 5 setting forth certain requirements relating to public school buildings. These structures, as a class, suffered the greatest damage in the earthquake.

These regulations lack design data relative to earthquake resistance, largely because such data do not exist. For example, there is available no satisfactory information as to the rigidity, bending resistance or shear resistance of wood floors and roofs, except such work as has been done by one of the authors (*ENR*, Oct. 27, 1932). Likewise there is little conclusive evidence as to the holding power in either tension or shear of so-called anchor bolts in either brick or tile masonry or of the shear resistance of anchor bolts in concrete. These problems have been selected, from among many others, as of the most immediate importance, and a test program has been initiated in an effort to obtain the most needed fundamental information in the shortest time possible. This test program is being carried out by the authors for several groups, among them being the Retail Lumbermen's Association of Long Beach, the Lumber and Allied Products Institute of Los Angeles, the National Lumber Manufacturers Association and the Clay Products Institute of California.

In general, the program is intended to furnish information which will permit the rational design of wood floors (or roofs), the connections between brick or tile walls and wood floors, and the walls themselves, in so far as earthquake safety in bearing-wall buildings is concerned.

The tests thus far planned may be divided into three parts:

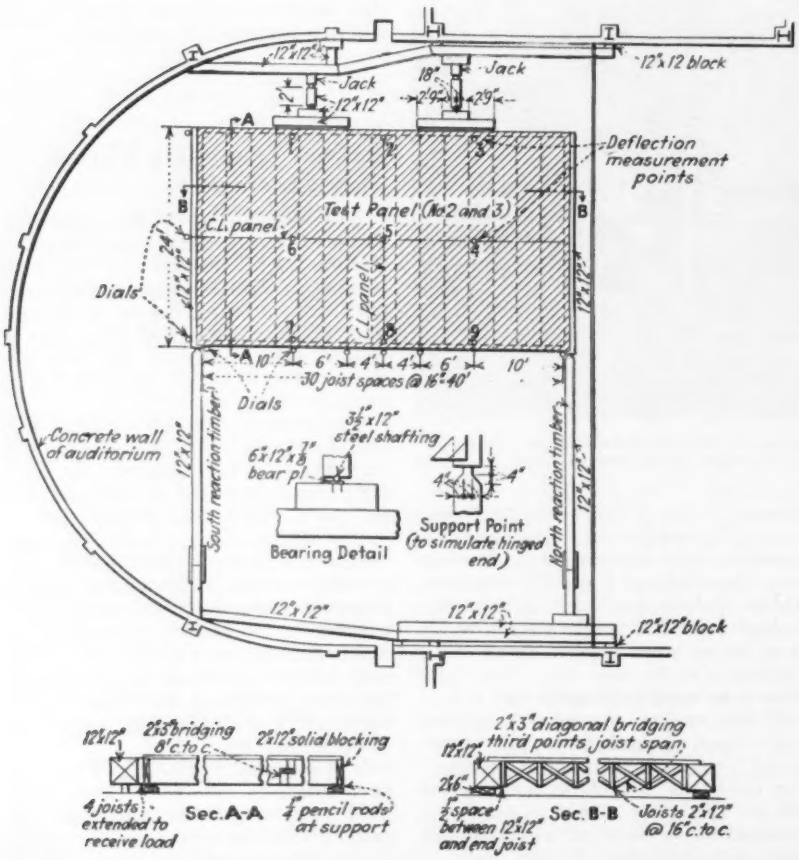
1. Lateral tests of full-size floor panels with varying arrangement of flooring and subflooring.

2. Lateral tests of one-quarter-scale model floor panels, first duplicating the full-size tests, and second introducing other variables such as ratio of span to length, size and arrangement of joists with respect to direction of applied load, size and number of nails, size and arrangement of flooring and subflooring, and effect of lapping joists.

3. Tension and shear tests of bolt anchors in brick and tile walls, varying the type, size and arrangement of anchors, as well as the thickness and mortar mix of both the brick and the tile walls.

Part 1 of the test program was completed at Long Beach, Calif., during December, 1933. The other two parts of the program are now under way and will be completed as rapidly as possible. Data on the full-sized floor tests are published prior to the completion of the entire program because of many urgent requests for such information.

FIG. 1—LAYOUT OF TEST PANEL of wood floor in Long Beach auditorium. The steel columns and concrete wall of the building were used as reactions for the lateral loads applied by the jacks.



Full-size tests

These tests were made on floor panels 24 ft. wide and 40 ft. long, constructed on the concrete floor of the Long Beach Municipal Auditorium. The steel columns and concrete walls of the auditorium were used as supports and reactions for the lateral load, as shown in the test set-up, Fig. 1.

Two pneumatic jacks, each having a capacity of more than 50 tons, were used to apply the load, which was determined from a pressure-dial reading. The load at each jack was carried through a distributing beam to two

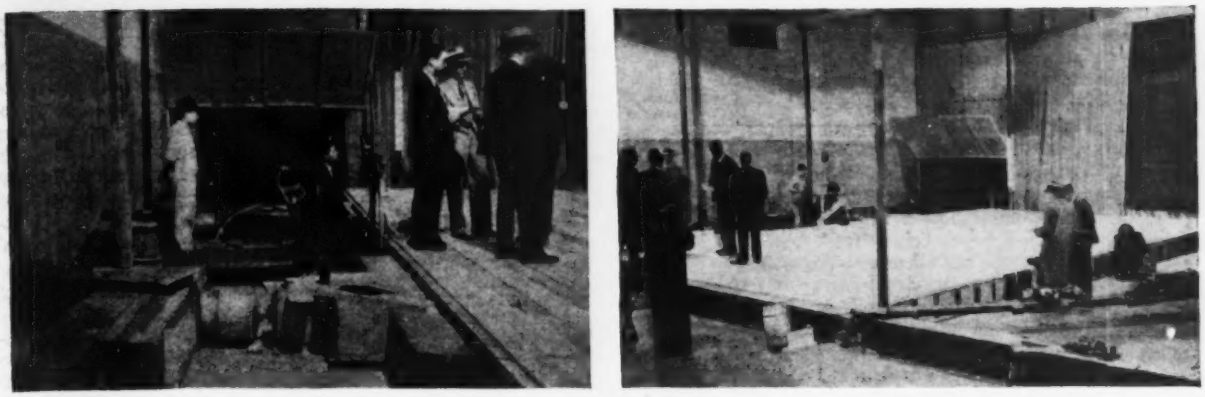


FIG. 2—TWO VIEWS of 24x40-ft. wood-floor panel under test, showing (left) jacks applying loads at fifth-points of the panel length and (right) readings of the deflections being taken on the edge of the panel opposite the loading jacks.

joists, so as to give equal fifth-point loads on the panel. (The equivalent uniform loading that would produce equal bending moment at the center of the panel span would be 1.2 times as great as the total concentrated loads applied divided by the panel length of 40 ft.)

Three panels were tested, each panel being identical except as to the arrangement and nailing of the flooring:

Panel No. 1 had one layer of 1x6-in. x14-ft. boards, laid at right angles to 2x12-in. joists (with a ¼-in. crack between boards to simulate shrinkage), nailed at each joist with two 8d common nails. Butts on adjacent boards were staggered two joist spaces.

Panel No. 2 had two layers of boards, the lower layer (subfloor) of 1x6-in. x 12-ft. boards being laid at 45 deg. to 2x12-in. joists, with ¼-in. cracks between boards, and nailed with two 8d common nails at each butt; the upper layer, of 1x4-in. x 14-ft. square-edged boards, was laid at right angles to the joists without cracks between boards and nailed with two 8d finishing nails at each joist (not "blind-nailed"). All butts were staggered two joist spaces.

Panel No. 3 had two layers of 1x6-in.x 12-ft. boards laid diagonally, at right angles to each other, at 45 deg. to the 2x12-in. joists, with ¼ in. cracks between boards; the bottom layer was nailed with two 8d common nails at each joist, and the upper layer with two 16d common nails at each joist, the butts being shifted two joist spaces as for the other panels.

Each test panel was nailed at the north and south edges to 12x12-in. timbers which served as reaction members.

The lumber was an average grade of No. 1 common Douglas fir, in a relatively green condition, with about 30 per cent moisture content.

Loads were applied to the panels in varying increments, as indicated by the points shown on the curves in Fig. 3. The time between applications of successive increments of load varied from 5 to 15 min. or more, depending on the number of measurements taken.

Movement of the panel with relation to the concrete floor was measured at the center of the edge of the panel opposite the load by an Ames dial. The movements of the reactions were measured by Ames dials; and the net movement of the above-mentioned panel point, after adjusting for reaction movements, is the deflection plotted in Fig. 3.

Movements of the panel at a given load were also measured by steel scale at nine points on the panels, as indicated in Fig. 1. The manner in which the panels deflected is of interest, but this article deals only with maximum deflections, which occurred in every case at the center of the length of the panel on the edge opposite to the jacks.

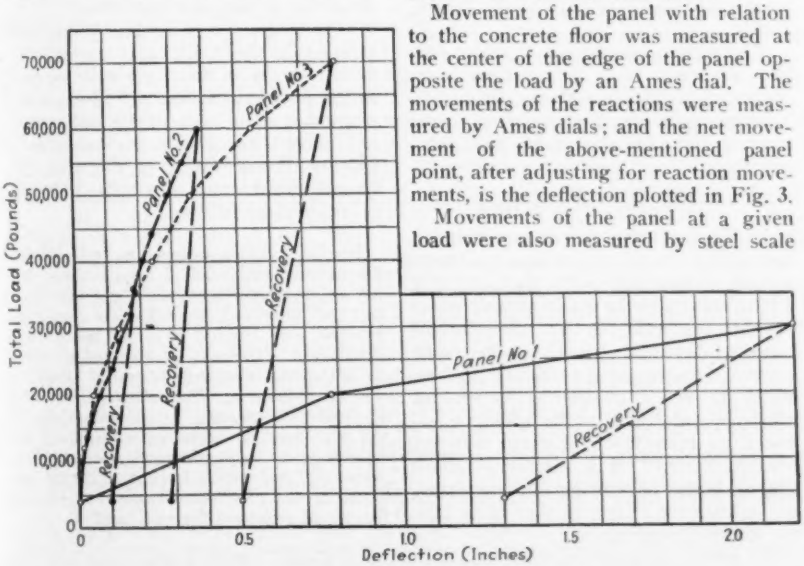


FIG. 3—NET DEFLECTION READINGS for three types of panels tested. Ultimate strengths of panels 2 and 3 were not approached, but panel 1, with no diagonal flooring, was definitely flexible and weak.

Load-deflection curves

As expected, panel No. 1 proved to be very flexible. Owing to an oversight, deflections at loads less than 20,000 lb. were not taken, so that the form of the curve below that point is not known, although it is indicated as a straight line on Fig. 3. A determination of the form of this portion of the curve can probably be made after the one-quarter-scale model floor tests are completed.

None of the curves shows any well-defined proportional or elastic limit. The data on recovery of panel No. 2 when load was taken off indicates the desirability of further investigation of this phase of the problem. It is unfortunate that recovery data were taken only at relatively high loads, since the variation in the slope of the recovery lines indicates that there may be a load below which the recovery would be 100 per cent. In connection with earthquakes the possibility of the panel "working" under repeated or reversed load also becomes important and can be investigated in the one-quarter-scale model tests. (Some light on this problem may be obtained from a report on "The Strength and Rigidity of Frame Walls" by George W. Trayer, Forest Products Laboratory, Madison, Wis.)

The ultimate strength of panels No. 2 and 3 was not even approached, judging from the slope at the upper limits of the load deflection curves, and would undoubtedly be much higher than could be reached by the application of an earthquake force through any commercially practicable wall of whatever material. This should call attention to the fact that horizontal diaphragms of wood in a building subjected to lateral forces will usually be adequately strong but

may not be sufficiently rigid to prevent rupture of walls which depend on such floors for lateral support.

The effect of the time required in applying the test load should be taken into consideration in interpreting the test data. With the apparatus employed, it required several minutes to build up a given load increment; moreover, the Ames dials showed a slight creep while they were being read. These facts seem to indicate that a given load applied for a brief period only and then reduced to zero or reversed, as in an earthquake or wind, might not have sufficient time to produce deflections as large as those measured in the panel tests for an equivalent load.

The facts that the panel tests were made using green lumber and that the floor was laid with ¼-in. cracks between boards (simulating shrinkage) should also be considered in interpreting the tests. As shown in a recent memorandum received from the Forest Products Laboratory, "The lateral resistance of nails driven in green wood and loaded while the timber is still green is less than their resistance in seasoned wood." Other factors, such as the effect of reversal of stresses, also enter into the holding power of nails, and it seems desirable that additional tests be made to furnish more complete data on this subject.

None of the panels showed any marked signs of failure at maximum loads, except that the butts of the upper layer of boards separated a maximum distance of ⅛ in. in panels Nos. 2 and 3 at the center of the unloaded edge of the panel; this separation decreased in amount each way along this edge as well as toward the loaded edge of the panel, suggesting simple beam action.

The analytical conclusions relative to the strength of wood floors, as presented in a previously mentioned paper, are of interest in connection with these test results. The expected weakness of single longitudinal flooring was exhibited by the test of panel No. 1; while a comparison of the relative flexibility of panels Nos. 2 and 3 shows the stiffening influence of the longitudinal flooring in resisting direct bending stresses. The test of panel No. 2 also indicates a surprising efficiency for single diagonal sheathing in resisting shear forces. The tabular values for the shear and bending resistance of wood floors, as presented in the article previously mentioned, were arrived at without reference to deflections, although they were based on the proportional limit strength of the nails and were expected to represent the commencement of a yielding of the panel as a whole, with a factor of safety of about two against ultimate failure. In the above mentioned tables, for a panel 25 ft. wide having double diagonal and single longitudinal flooring with 12-ft. boards, the shear resistance governs for a panel 40 ft. long, and is given as 35,800 lb., or a total of 71,600 lb. No panels with three layers of floor were tested at Long Beach. However, panel No. 2 was loaded to 60,000 lb. and panel No. 3 to 70,000 lb. with no evidence of a yield point, while the ultimate strength was evidently very much higher.

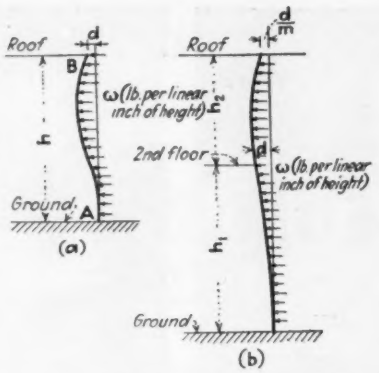


FIG. 4—STRIP OF WALL, considered as a vertical beam carrying a uniform load due to its inertia, will deflect at roof line, under a lateral load, an amount depending upon the tensile stresses in the masonry at the base of the wall, which should be kept below one-fourth of the modulus of rupture.

A wood-floor panel loaded laterally appears, from these tests, to deflect in a manner analogous, but not exactly similar, to a solid wood beam. The deflection of each results from a combination of shear and bending, but the fibers of a beam parallel to its length are, in effect, continuous, while those of a floor are interrupted or weakened at every nailed butt. This indicates the importance of board length in a floor as well as the importance of adequate nailing in securing stiffness.

The direct supervision of the tests was in charge of C. D. Wailes, Jr., a structural engineer of Long Beach, Calif.

The jacks with the necessary operating apparatus and an operator were loaned by LaBarre and Converse, consulting engineers, Los Angeles, whose interest and assistance in the tests were invaluable.

Application of test data

In the following discussion it is assumed that the floors and roofs are connected to masonry walls by bolting a joist (rafter) to the walls (where joists parallel the wall) or by bolting solid blocking between joists to the wall (where joists are perpendicular to wall) in such a manner as to develop adequate shear and tensile strength between joists or blocks and the wall, in both directions. It is further assumed that all layers of flooring and sheathing are adequately nailed to the joists and to the solid blocking.

To arrive at some conclusion as to the requirements for a floor or roof under given load conditions, consider the simplest case, that of a one-story building with masonry walls. Any lateral force exerted against the side walls of such a building will be resisted by (1) horizontal beam action of the side wall acting as a restrained beam between two supports (the end walls); (2) vertical beam action of the side wall, considered as a beam restrained at the ground and supported on a yielding reaction at the roof; and (3) diaphragm action of and through the roof to the end walls.

The deflection of the wall at the point of attachment to the roof must be the same as the deflection of the roof, consequently the total lateral load on the side wall at that point will be divided among the three above-mentioned elements in proportion to their rigidities. On this basis it is evident that, for a building of usual proportions, nearly all the load will be carried through the roof to the end walls. The assumption that all the load is carried through the roof is on the side of safety, since it will indicate a greater deflection of both roof and wall, and consequently greater flexural stresses in the side wall.

This assumption determines the load, under given conditions, which a roof must carry; and test data, if or when available, will give the corresponding deflection. The masonry acting either as a horizontal beam or as a vertical beam has this same deflection at the roof line. If, then, a given roof assembly is to be investigated under given load conditions, the deflection obtained from test data may be used as the deflection of the wall, and the unit stress in the masonry due to this deflection may be calculated for the two conditions, vertical and horizontal beam action. It will be found that stresses due to horizontal beam action of the wall need not be considered unless the length of the side wall is less than three times its height, which would be an unusual condition.

If it is desired to assume permissible stresses in the brick wall acting as a vertical beam so that the tensile stresses in the masonry, which will always be a maximum at the base of the wall, would not exceed one-fourth the modulus of rupture, the deflection of the wall may be calculated from Formula 1, which is obtained as follows.

In Fig. 4 AB is assumed to be a vertical strip of the side wall of the building, acting as an elastic beam with one end fixed and the other end supported on a yielding reaction, the amount of yield being indicated by d. The wall is assumed to carry a uniformly distributed lateral load w due to its inertia. The effect of the roof in developing moment at its connection to the wall may be neglected in view of the flexibility of any practicable connection. Applying conventional elastic curve analysis to the given conditions and solving for d, the resulting formula will be:

$$d = \left[\frac{2SI}{T} - \frac{wh^2}{8}\right]\frac{h^2}{3EI} \qquad (1)$$

in which (for a 12-in. strip of wall)

d = deflection of wall at roof line, in inches;
h = story height, in inches;
E = modulus of elasticity of the wall material;
T = thickness, in inches, of the wall section;
I = moment of inertia of wall section;
w = uniform lateral load on wall, due to its inertia expressed in lb. per sq. ft. divided by 12—i.e. lb. per inch of height;
S = unit flexural stress at base of wall per sq. in. (being the sum of initial compressive stress in the wall due to vertical loads plus the unit stress in tension developed by the bending of the wall).

In the case of a two-story building it becomes necessary to make an assumption as to the relation between the deflection at the floor line and the deflection at the roof line, each being considered as yielding supports.

Designating this ratio of floor deflection to roof deflection as m, the height of the first story as h, and the height of the second story as h_2, and applying the elastic curve equation for a beam fixed at one end and resting on two yielding supports:

$$d = \left[\frac{w h_1^3 + 2 w h_2^3}{24 h_1 + 32 h_2} - \frac{w h_1^2}{8} + \frac{2 S I}{T}\right] \times \left\{\frac{3 h_1^3 h_2 + 4 h_1^2 h_2^2}{3 E I\left[3 h_1 h_2 + 4 h_2^2 + 2 h_1^2\left(1 - \frac{1}{m} + \frac{3 h_2}{2 h_1}\right)\right]}\right\} \quad \ldots\ldots (2)$$

In this case also, S represents the unit flexural stress at the base of the wall, since, for all probable combinations of d and m in practicable story heights, that stress will be the maximum developed in the wall.

Formula (2) is rather cumbersome, but it becomes very simple for the case in which the first and second stories have the same height h, in which case:

$$d = \left[\frac{2 S I}{T} - \frac{w h^2}{14}\right] \left[\frac{7 h^2}{6 E I\left(6 - \frac{1}{m}\right)}\right] \quad \ldots\ldots (3)$$

It will be found that Formula (3) is sufficiently exact unless there is a considerable difference in the story heights.

As stated above, wall deflections calculated from the above formulas under stated conditions of building dimensions, earthquake forces, allowable stresses, etc., may be used as the limiting deflections for floors or roofs when it is necessary to provide adequate support for side walls subjected to lateral forces. The accompanying table has been drawn up to give some idea of how the test data reported in this paper may be applied.

An examination of the table and the load-deflections curves of Fig. 3 indicates that, for a one-story building 26 ft. wide (over-all) only panels 2 or 3 of those thus far tested would afford sufficient stiffness to support the side walls of a building 40 ft. long. It also indicates, by comparing columns 9 and 12 of the table, that the construction used in either panel 2 or 3 would be adequate to support a wall considerably longer than 40 ft. in a building having a width of 26 ft. An attempt has been made, in the last two columns of the table, to indicate the permissible length of wall that could be used if the measured deflection of test panel 3 (column 12) were increased to the calculated allowable wall deflection shown in column 9. We know that the deflection of a roof or floor is produced partly by shear and partly by bending, and from analogy with beams it seems probable that the shear deflection in roofs or floors would vary directly as the square of the length, while that due to bending would vary as the fourth power of the length (the uniform load per foot remaining constant).

Considering the example in the first line of the table, the deflection shown in column 9 (0.11 in.) is equal to 5.5 times the deflection shown in column 12. Therefore, if deflection varies as the square of the length of panel, it would be permissible to use a wall $\sqrt{5.5} \times 40$ ft., or 94 ft. long. On the other hand, if the deflection varies as the fourth power of the length it would be permissible to use a wall only $\sqrt[4]{5.5} \times 40$ ft., or 61 ft. long. In view of the relatively great importance of shear deflection in beams of small length-depth ratio, it seems probable that the deflection in two similar floors of different length will vary more nearly as the second power of the length than as the fourth power.

The effect of increasing the width of floor panels, keeping the length constant, will certainly be to decrease the deflection of the panel, but the ratio of decrease is quite unpredictable. The effect of increasing or decreasing the area of panels, keeping ratio of length to width constant and applying an equivalent uniform load per foot of length, is also uncertain, and further tests are needed to establish these relations.

AN ANALYSIS OF WALL AND FLOOR DEFLECTIONS UNDER EARTHQUAKE LOADS

Assumed Conditions								Calculated Allowable Wall Deflection, In.	Calculated Lateral Load Lb./Lin. Ft.		Measured Deflection Test Panel No. 3 (At loads in Cols. 10 and 11)	Length of Wall (L) Permissible with 24-Ft. Width and Maximum Allowable Deflec., Ft. If d Varies as	
Building					Vertical Load, Lb./Sq. Ft.		Lateral Load, Lb.						
Story Height, Ft.		Width, Ft.	Length, Ft.	Wall Thickness, In.									
1st (h_1)	(h_2)		(L)	(T)	Roof	Floor	(w)	(d)	Roof	Floor		L^3	L^4
1	2	3	4	5	6	7	8	9	10	11	12	13	14
15	None	26	40	13	30	None	1	.11	324	...	.02	94	61
18	None	26	40	13	30	None	1	.14	360	...	.025	95	61.5
15	12	26	40	13	30	75	1	.084	...	504	.05	52	45.5
18	12	26	40	13	30	75	1	.106	...	540	.055	55.5	47

NOTES:

Cols. 1 to 5 are given conditions used for the purpose of analysis.

Col. 6 is based on the usual building-code requirements for roof loads.

Col. 7 is based on a 15-lb. per sq.foot dead load plus 60 per cent of a 100-lb. live load.

Col. 8 is based on a seismic coefficient of $1/10g$, and the value of w is 1/12 of the weight of T inches of brick wall per square foot of area multiplied by the seismic coefficient $= \frac{120}{12} \times \frac{1}{10} = 1$ lb. per linear-inch of height.

Col. 9 is calculated from the above values and with the following assumptions:

E for brick masonry = 800,000 lb. per sq.in.

S = calculated initial compressive stress at base of wall due to vertical loads plus a safe allowable unit stress in tension (combined dead, live and earthquake loads) for brick masonry of good quality (assumed at ¼ of modulus of rupture, or 50 lb. per sq.in. In calculating the initial compressive stress a 3-ft. parapet wall above the roof line has been assumed.)

For two-story buildings Formula 3 has been used, with a value for m of 1.5 (the largest value likely to occur in an ordinary building) and a value for h of the average story heights given in Cols. 1 and 2.

Cols. 10 and 11 are calculated from the given conditions, using a seismic factor of $1/10\ g$ and assuming the roof or floor to sustain the lateral force acting against one-half the story height of wall (plus 3 ft. of parapet in the case of the roof).

Col. 12 is taken from the test data shown in Fig. 3. It is the deflection of panel No. 3 for the calculated loads shown in col. 10.

Cols. 13 and 14 show the length of wall permissible if the deflection in the wood roof or floor equals the calculated deflection in the brick wall, the width remaining constant.

Railway Water Pick-up Improved

To check loss of water at track tanks serving high-speed trains, where the amount lost by spillage may be nearly equal to the amount delivered to the tender, the London, Midland & Scottish Railway (England) is experimenting with a deflector mounted about 16 in. in front of the water scoop. Investigation has shown that with the standard 10-in. wide scoop in the 17-in. track tank, the water is thrown out in a wave on each side. The new deflector consists of two vertical blades set 10 in. apart in front and 8 in. at the rear, so that they throw the water between the deflector and the scoop into a ridge along the middle of the tank and thus below normal level at each side. With this arrangement not only is the waste or spillage reduced, but the engine takes a given amount of water in a shorter distance. At the same time there is an advantage in the smaller amount of water poured over the track and roadbed.

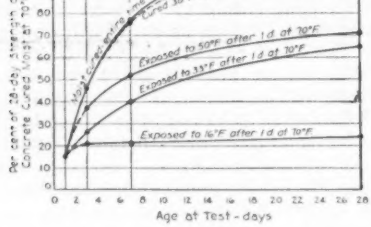
A Guide to Winter Concreting

Tests with modern cements supply data previously lacking on strengths obtained in cold-weather concrete construction

By F. R. McMillan
Director of Research, Portland Cement Association, Chicago, Ill.

THE RESEARCH LABORATORY of the Portland Cement Association has just completed a series of tests which show the strength of concrete under conditions approximating those frequently encountered when placing concrete in cold weather. The tests were made on 3x6-in. concrete cylinders stored for various periods at temperatures of 50, 33 and 16 deg. F. They cover also the effect of different periods of preliminary curing at 70 or 50 deg. F. before exposure, and various periods of storage in warm air after removal from the cold room.

A feature of the study that makes it particularly timely was the inclusion of two high-early-strength portland cements. Three concrete mixtures, having


Per cent of 28-day strength of Concrete Cured Moist at 70°F
Cured 24 hours in mold at 70°F, then moist and in air at 70°F
Exposed to 50°F after 1 d. at 70°F
Exposed to 33°F after 1 d. at 70°F
Exposed to 16°F after 1 d. at 70°F
Age at Test - days

RELATIVE STRENGTH of concrete as influenced by storage temperatures.

water contents of 4½, 6 and 9 gal. per sack of cement, were used with each cement. Two temperatures of concrete at time of placing, 70 and 50 deg. F., were also used.

Illustrative of the data developed is the accompanying diagram for concrete of normal portland cement, water content 6 gal. per sack, cured one day at 70 deg. F. before exposure to the temperatures of 16, 33, and 50 deg. F. Ordinates to the several curves represent percentages of the 28-day strength of specimens moist-cured at 70 deg. F. The solid-line curve at the top represents the strength of specimens cured moist at 70 deg. F. until time of test. The dash-line curve gives percentages for concrete cured one day in molds, then two days moist, then in air at approximately 70 deg. F and 50 per cent relative humidity, unprotected until time of test. For the other curves the specimens were tested two to three hours after removal from the cold room. All specimens were soaked two to three hours before testing.

Diagrams for other initial strengths, shorter or longer periods of initial curing, and other mixtures and cements, have a similar general form, but the curves below the curve for all-moist curing are higher or lower in position according to the individual conditions. For example, for high-early-strength cements, with one-day initial curing at 70 deg. F., the curves are relatively higher; with ¼-day initial curing at 70 deg. F. they are in approximately the same position for exposure temperatures of 33 and 50 deg. F. as in the diagram shown. Again, the percentage curves for normal portland with three-day initial curing are higher than in the diagram shown and are approximately comparable to those for high-early-strength cement with one-day initial curing. The percentage strengths shown by the latter two diagrams for exposure temperatures of 33 and 50 deg. F. are in the neighborhood of 75 per cent of the strengths for all moist curing, which is considered a minimum desirable value for field practice.

The most significant information developed by the tests was the importance of the strength of concrete at time of exposure in influencing the later strengths. The desired initial strength can be obtained by the use of lower water contents, longer preliminary curing or the use of high-early-strength cement.

Suggested rule for ordinary practice

The tests indicate that when the temperature of exposure is from 33 to 50 deg. F. the initial curing at 70 deg. F. should be at least three days for normal cement and at least one day for high-early-strength cement. When the temperature of exposure is below freezing, these minimum initial curing periods should be materially increased.

A complete report of these tests will appear soon in the *Journal* of the American Concrete Institute as a paper by A. G. Timms and N. H. Withey. The paper will be one of three on the general subject of winter concreting on the program of the annual convention of the Institute to be held in Toronto, Ontario, Feb. 20 to 22.

Earthquake in Japan Affects Tide Gage in Golden Gate at San Francisco

A RECORD of the Japanese earthquake of March 3, 1933, on the tide gage at San Francisco draws attention to the fact, well known to seismologists that seismic shocks travel long distances across bodies of water in the form of stationary waves or seismic sea waves. On that date abnormal water-level fluctuations occurred just inside the Golden Gate and, although of a continually decreasing amplitude, these fluctuations were strong enough to continue to show on an ordinary tide gage for more than 24 hours. This same phenomenon has been observed over a period of years, whenever there was a severe earthquake in Japan. On the other hand, shocks originating along the Pacific Coast usually do not register on the San Francisco tide gages. One suggested explanation is that shocks of oriental origin are believed to result from vertical movement of the ocean bottom, and that this type of seismic disturbance propagates a seismic sea wave, while horizontal movements of the earth's crust do not. Vertical displacement of earth crust itself actually in contact with water is said to be a prerequisite to propagation of seismic sea waves. Land shocks may be felt on water near by, but seismic waves not of submarine origin do not travel long distances through water.

The rate of travel of seismic sea waves is reported to vary with water depths and other conditions from 375 to 450 m.p.h. Some long distance effects are on record: a quake in Ecuador was felt in Sukahori, Japan, 9,992 miles away, and another in Valparaiso was recorded at Kushimoto, Japan, 10,937 miles distant. As such oscillations diverge from the epicenter, they diminish rapidly in amplitude. At first they become long low swells, perhaps 100 or 200 miles in length, but at distances of a few thousand miles they no longer resemble sea waves, partaking more of the nature of miniature tides with a period of 20 to 30 min.

In a recent report of the National Research Council the subsidiary committee on oceanography points out that despite its slight compressibility, sea water responds as an elastic body to the short-period oscillations of submarine earthquakes, the velocity of progression in these oscillations being equal to that of sound. To a ship on the surface of the ocean they manifest themselves by a sharp and sometimes violent shock much like that caused by a vessel striking a reef.

In fact, to this cause are ascribed numerous reefs recorded on old charts, but shown by modern oceanographic research to be non-existent.

Highway Progress Reviewed at A.R.B.A. Convention

Prospective employment from Recovery Act funds—Need of continued federal appropriations—Civil works operations outlined

A DECIDED CHANGE from the past few years characterized the technical proceedings in convention of the American Road Builders Association, which met in Chicago Jan. 22-25. The numerous and bulky committee reports of former years were replaced by a modest half-score of individual papers divided between roadbuilding technique and the planning and progress of the road construction being carried on with Recovery Act appropriations. In the latter division are to be included several papers on civil works operations, although these discussions commonly ranged the field of civil works projects instead of being confined to highway and street improvement. Incidentally the civil works papers brought out about the only really interested discussion of the convention sessions apart from the discussion of association organization and financing, action on which is reported on p. 152 of this issue.

Progress of $400,000,000 program

A factual statement of employment and types of work resulting from the $400,000,000 Recovery Act appropriation was given as of Dec. 31, by Thos. H. MacDonald, chief, Bureau of Public Roads. The accompanying table is a summary of costs of mileages by types of construction. Referring to employment, Mr. MacDonald estimated that the full $400,000,000 would provide "a cumulative total employment of direct labor on the job of 2,500,000 man-months." Tracing the course of employment, he said:

Beginning with August, 1933, the daily average employment directly on the work was gradually stepped up until it reached for November, 132,000 men. This figure is for continuous employment and must not be confused with the number of individuals given work. Our records so far show a ratio of 1.8 individuals included on the payrolls for each one reported continuously employed. That is, the work to provide continuous job employment for 132,000 men represented in November employment for longer or shorter periods of 236,000 individuals directly on the work. Nor does this take into account the auxiliary industrial employment.

For November our estimates for direct and industrial employment indicate that the highway program was carrying a total of 330,000. The total was held to approximately the same figures for December, and there is no indication of a falling off during January and February. There will unquestionably be a rapidly increasing rate of employment through March, April and May, to a peak in June and July of about 280,000 average daily continuous employment. Nearly one-half million individuals will go on the payrolls to fill this number of jobs continuously. This employment will hold through July and part of August and will then fall rapidly until the first of the year when the work will have been practically completed.

The completion of this program, as federal appropriations now stand, will end the federal cooperative highway work with the state highway departments unless there is additional federal legislation meantime to provide for its continuance.

Express roads and grade-crossings

Continuing the theme of federal appropriations for highways, Oscar L. Chapman, assistant secretary of the interior and executive secretary to the special board of public works, pointed out that besides the $400,000,000 to states the Recovery Act had by mandate allotted $50,000,000 to parks, reservation and other federal-land roads, and $15,000,000 had been granted by the PWA for road work on various federal properties. This $465,000,000 included no Recovery Act funds borrowed for road construction nor any funds used for highways by the CWA.

Stating that he had "supposed that so far as highways generally are concerned, the country as a whole is fairly well supplied," the assistant secretary considered that "What we must look for now is not so much an extension and multiplication of the existing system but rather an improvement of the roads we already have." Two of the most fertile fields, he considered, were the building of express highways and the elimination of road-rail crossings at grade. "Statistics show," said the assistant secretary, "that the number of grade-crossings is increasing. They also show that railway mileage is on the decrease, from which one can only draw the conclusion that more roads are being built which cross existing railroads." Asserting logically that grade-crossings are wide spread and so their construction would spread employment widely, and that they are particularly adaptable to winter construction, Secretary Chapman pointed out that "They are comparatively simple to construct and do not require extensive blueprint work."

Future federal aid

Stating that in fifteen years $30,000,000,000 had been invested in highways and in motor vehicles and developments to service them, E. B. Jeffress, chairman, North Carolina Highway Commission, called for long-time planning and continued federal aid. The immediate need of the highway departments, he stated, is for the adoption by congress and by the various states of an adequate program, spreading over the next two or three years, so that the

U. S. PUBLIC-WORKS HIGHWAY PROJECTS SUMMARY BY TYPES OF CONSTRUCTION

(As of Dec. 31, 1933)

Types	NRH Projects Estimated Total Cost	NRH Projects Miles	NRM Projects Estimated Total Cost	NRM Projects Miles	NRS Projects Estimated Total Cost	NRS Projects Miles	Total Estimated Total Cost	Total Miles
Graded and drained	$19,838,939	2,408.0	$2,046,594	92.9	$10,284,007	1,648.1	$32,169,540	4,149.0
Sand clay, untreated	853,926	228.6	79,996	12.1	1,774,452	329.2	2,708,374	569.9
and treated	2,388,851	314.7	138,980	16.6	1,676,916	226.4	4,204,747	557.7
Gravel, untreated	17,025,178	2,185.6	630,927	66.9	14,990,160	2,721.0	32,646,265	4,973.5
and treated	4,027,759	431.8	609,616	39.6	7,400,845	846.3	12,038,220	1,317.7
Macadam, untreated	1,677,416	103.3	146,409	7.0	488,541	93.5	2,312,366	203.8
and treated	2,015,140	122.4	357,442	11.4	1,504,827	104.7	3,877,409	238.5
Low-cost bit. mix	12,346,259	1,461.7	733,257	48.0	2,838,124	291.4	15,917,640	1,801.1
Bit. macadam	5,930,043	249.5	1,613,929	33.1	2,704,465	178.5	10,248,437	461.1
Bit. concrete	9,076,174	363.0	10,834,456	167.1	2,895,746	175.9	22,806,376	706.0
Portland cement concrete	59,176,502	1,865.6	24,132,858	430.0	8,108,774	225.3	91,418,134	2,520.9
Block	1,704,414	30.0	2,453,070	28.0	351,050	5.0	4,508,534	63.0
Bridges and approaches	18,617,074	50.8 (160)	6,831,849	7.5 (199)	6,812,839	13.9 (631)	32,261,762	72.2 (2431)
Grade separations railroad-highway	2,892,474	7.1 (82)	2,239,437	3.0 (45)	679,166	2.0 (23)	5,811,077	12.1 (150)
Grade separations between highways	68,450	.2 (2)	635,443	.3 (7)			703,893	.5 (9)
Miscellaneous	107,892		48,674		59,844		216,410	
Total	$157,746,491	9,822.3	$53,532,937	963.5	$62,569,756	6,861.2	$273,849,184	17,647.0

Note: The figures in parentheses indicate the number of structures.

work can be properly planned and executed in an orderly manner. Such a program, if adopted within the next 30 days, would be a great stimulus to national recovery because it would enable full advantage to be taken of the present $400,000,000 highway fund.

If highway departments knew that a definite three-year program was in sight, many very desirable and worthy projects could be planned and undertaken, whereas when funds come piecemeal, adequate planning is impossible and the best results of the dollars spent cannot always be obtained. Rushing highway lettings, without opportunity for careful study, is always costly. Referring specifically to federal aid, Mr. Jeffress said:

The federal government must continue federal aid, and after the emergency it must require the states to participate in matching federal aid, otherwise highway revenues are liable to be diverted to other than highway projects, highway maintenance and highway debt service.

The federal government is to a large extent the beneficiary of the motor industry. It is now levying special terms on gasoline, on tires and automobiles and accessories, to say nothing of income taxes levied upon motor manufacturers and allied industries. It is therefore proper that the federal government should continue regular federal aid for highway construction and that it should also in the time of the present emergency continue an emergency program of highway construction in order to cope with the unemployment situation, and in so doing provide the facilities that are useful and economically and socially sound.

CWA operations

In a joint session of the city and county divisions, CWA operations, administration and supervision were discussed in four papers. Frank D. Chase, director and chief engineer for the Illinois CWA, told of the program to rebuild 100 miles each of macadam and asphalt streets in light-traffic residential areas of Chicago where the pavements had become all but impassable. This is but a small percentage of the work needed, hence it will not curtail any work that may be done later by contractors. Understanding this, the contractors have cooperated fully, and nine asphalt plants are now operating, of which three belong to the city. A better job could be done, Mr. Chase said, if 10 per cent more, making 35 per cent in all, could be paid for materials. Getting requisitions authorized for early purchases to satisfy federal authorities has been difficult, and the procedure has not yet been fully ironed out. The discussion brought out that there is a difference in the ratio of material and labor, ranging from zero in New York and Kansas up to 30 and even 50 per cent, but averaging 25 per cent. At the close a resolution calling for 35 per cent was passed.

Donald C. Stone, director of Public Administration Service, Chicago, has been in Washington working on simplification of accounting records and requisitions. A manual has been prepared for the guidance of CWA officials. All information now can be set forth on four forms, whereas many organizations have used from 15 to 30 forms. Mr. Stone thinks the necessary red tape has been a good thing, for it has taught local governments the necessity of writing specifications, issuing requisitions, taking bids and getting supporting vouchers for expenditures. Trouble with wage rates seemed to be the greatest difficulty. R. Keith Compton of Richmond, Va., said that five rates were "standard" in Richmond: direct relief, 25c.; PWA, 45c.; city, 42c.; contractors on city work, 35c.; and federal-aid street work, 30c.

Methods of selection and supervision of projects in Ohio were described in a paper by G. J. Kane, chief engineer of the CWA for Ohio. He gave credit for fast employment of 240,000 men in Ohio to city and county engineers and to the survey that had been made by the Ohio Works Development Commission, which had laid the groundwork for both PWA and CWA projects. In consequence, CWA acted more as a checking agency. Only ½ per cent of early approved projects had to be cancelled. Local resources for material had to be exhausted, and then CWA would furnish 10 per cent. Of the projects 40 per cent were streets and highways, absorbing 47 per cent of the men employed.

Paul N. Coates, Ramsey County engineer, St. Paul, Minn., in speaking on the same subject, said that the character of the main projects consisted of ditching, clearing, rebuilding culverts, repair of road structures, land drainage, repair of schools, cleaning and grubbing, county forest work, airport maintenance, general surveys and mapping. Material varied from 5 to 50 per cent of the cost but averaged 22.2 per cent, and 4.2 per cent was chargeable to rent of equipment.

In discussion, Otto Hess, Grand Rapids, Mich., said the relief agencies were not always favorable to road projects, that prevailing wage rates should be used and that material percentages should be raised to 35 per cent.

Engineering and contracting

Two sessions, one for code discussion by contractors and one for technical papers, brought out four papers. Describing a survey made by state maintenance records in a joint research by the Bureau of Public Roads and the Highway Research Board, J. B. McCord, Bureau of Public Roads, stated that so many variations were found that no data of general appliation were possible. The committee had therefore arranged with 32 states (others were being solicited), each to keep maintenance records on 20 sections of road according to forms prescribed by the committee. Returns from these records were just beginning to come in.

A series of studies on the effect of 40-70 temperatures on concrete were reported by H. F. Clemmer, engineer of materials, District of Columbia. Primarily, the investigation was to get a quick-acting concrete for pavement base that would permit of quick surfacing and opening of streets. The tests brought out clearly that temperatures of the range indicated had a decided effect on strength at early ages (two days); concretes laid on a rising temperature showed less loss than those laid on a falling temperature, and additional cement with calcium chloride and high-early-strength cement both gave the necessary quick action, so that choice was a question of cost. The discussion brought out descriptions of several winter paving jobs with high-early-strength cement. Some of these will be described in a later issue.

In a paper on aerial topographic surveys for road work Talbert Abrams, of Lansing, Mich., touched on accuracy and cost. Cost, he said, should run from 1c. to 10c. an acre depending upon the size of the area to be mapped. Speaking of accuracy, he said:

Map negatives, as originally made, are ordinarily accurate within limits of 2 or 3 per cent. However, the laboratory has developed an instrument known as a distortion corrector which does three things: first, from the original negatives it enlarges or reduces the prints to any desired scale; second, through the medium of a tilting base on a universal joint, all tilt is taken from the print; third, and most important, the map print to be made is projected on the inside curve of a bowl, the curve of which matches the curve of the lens in the aerial camera. In this way all the distortion due to the curvature of lenses is eliminated, and the resulting prints are to be a uniform scale all over.

At the contractors' session Louis E. Guyott, chairman of the highway contractors' code executive committee, outlined the progress of the construction code development and presented the highway code in more detail. Consideration was given to forming a contractors' division of the association, but the proposal was voted down.

Resolutions

Urging the continued development of public roads, the association in general session passed the following resolutions:

RESOLVED, that Congress be urged to authorize at the earliest possible time additional funds for road construction for the fiscal year 1935, in such an amount as it may set aside for highways out of the additional total Public Works funds to be provided, and approximating the sum of $400,000,000 for highways together with allotments for forest, public land, national park and Indian Reservation roads appropriated for public works by the National Recovery Act.

RESOLVED, that this association demand the return to highway use of gasoline-tax and motor-license revenues, which are now diverted to purposes unrelated to highways.

Letters to the Editor

Employee Representation

Sir—In an editorial in the issue of Nov. 30 you make the sweeping charge that a letter sent out by the Federation of Architects, Engineers, Chemists and Technicians is "full of untrue and misleading statements" and dismiss the matter with the assertion that "It is not necessary here to attempt to refute statements made in that letter." It seems to us that you are coming dangerously near to exactly that of which you accuse our Federation—namely, of acting unfairly. It would seem not only fair but also necessary to print our letter and show exactly wherein our statements are either untrue or misleading. This is especially desirable in view of the hundreds of letters we are receiving from members of the American Society of Civil Engineers who take exactly the same view of the employer's code as we do.

As to your remarks about the Federation itself, you will, no doubt, agree with us that being "well known in the profession" is in itself no guarantee of fairness to employee interests, especially if the person concerned happens to be an employer, any more than being unknown is necessarily a criterion of unworthiness of trust or lack of zeal in the interest of employees.

It does seem to us that the American Society of Civil Engineers is in an anomalous position by appearing as the champion of a code conceded by all to be entirely favorable to employers and containing at the same time provisions for employees which are called into question on all sides. We readily concede the interest of the society in the profession as a whole, and even look to it to bring its influence to bear in the interest of code provisions that will benefit the employee engineers who constitute the vast majority of its membership. But it seems to us rather unfortunate that the society, having once been put in the unenviable position of sponsoring an admittedly inadequate code, should through its spokesmen berate the only employee organization when it takes issues with the employers and not with the society.

May we suggest that your treatment of the matter in "A Word of Caution" is reminiscent of the way the views of the labor organizations were treated by the dominant groups in the early days of the labor movement? We refer to the position taken that if a view does not jibe with that of the established group, it has to be ruled out as untruthful and suppressed, if possible.

It should be recognized that the moment that employer-employee relationships are considered there arise two distinct viewpoints. Neither of these necessarily rules out the other as untrue or baseless. The task is to harmonize the two views to the extent possible. This can best be accomplished by a frank recognition of the two interests and the joining of issue on the merits of any question as it arises. Nothing can be gained by assuming a "holier than thou" attitude and brushing the employee view aside as not coming from an established prominence and therefore not permitting consideration. MARCEL SCHERER,
Chairman, Federation of Architects, Engineers, Chemists and Technicians.
New York, N. Y.,
Dec. 16, 1933.

DETAILS of the circular letter above referred to, which some time ago was sent by the Federation to employee members of the American Society of Civil Engineers, are unimportant, and we did not feel nor do we feel now that proper service to the readers of *Engineering News-Record* requires or justifies taking space for the long and rambling document and for the necessary correction of what appear to us to be its many inaccurate and misleading or agitational assertions. What is important is the attitude of mind that it expresses. The same attitude is reflected in the statements made by the Federation's representatives at the engineers' code hearing in Washington and by some of its officers in its own meetings. The circular letter is charged with appeal to class prejudice, distortion of facts and insinuations of bad faith on the part of those who have prepared the engineers' code. The profession is unlikely to make progress on the basis of such an attitude, and we regard the entrance of the spirit of the labor agitator into the professional ranks as an evil to which all members of the profession should stand firmly opposed. If and when the employee movement puts forward constructive thoughts and proposals, it has possibilities of real usefulness because the interests of the employed engineer are important, especially at this time. *Engineering News-Record* welcomes constructive discussion of the problems of the engineering employee, either from individuals or from representative organizations. —EDITOR.

Two Bridge Failures

Sir—The account of the two bridge failures in the issue of Dec. 7, 1933, p. 687, should be of deep interest to bridge engineers.

The designers of the Anacostia bridge thought it entirely safe to build their piers through 3 ft. of water, 8 ft. of mud and 2 ft. of gravel, resting them on that same gravel. They did not foresee that the restriction of the channel by the piers themselves would speed the water flow and cut the bed. Neither did they know that the channel below the bridge would be dredged and widened, an operation that was bound to contribute to the scouring of the original channel where the dredging stopped, since (1) it created in effect an earth or mud dam that was constantly overtopped; and (2) it reduced the resistance to the flow of the water, thereby increasing the velocity at the bridge.

The failure of the New Mexico bridge resulted from the washing away of an abutment on the outside of a long sweeping curve turned by the stream. The abutment stood, unprotected except by dirt, in the path of the river's natural meandering, and was unequal to the task.

The moral of both failures seems clear: "Don't depend too much on mud and dirt to hold a mad river." In other words, "Don't send a boy on a man's errand." G. D. HOUTMAN.
Media, Pa.,
Dec. 15, 1933

Specialists Overlooked

Sir—The writer has read with interest the letter of Carl Weber in your issue of Dec. 7 in which he raises some questions as to the operation of the proposed engineers' code. In the same issue your editorial "A Fundamental Issue" gives a fine presentation of the basic idea behind the code and answers in main most of Mr. Weber's objections. But the fact remains that many consultants have, and do now, go to manufacturing or construction firms for advice and even design plans, rather than to a brother consultant in that special line of engineering practice. And the fact that there may be no one in private practice who is so specializing is largely due to that very cause; this free "sales engineering service" has robbed him of a field of opportunity in which he could capitalize this special knowledge and training in private practice as a consultant rather than as a salaried employee.

Whenever our consultants as a group come to recognize this fact and have the candor and honesty to go to their client and admit their lack of knowledge and training to handle these special problems and suggest that another be called in, then we will have taken a long step forward in the direction of public recognition of civil engineering as a profession rather than a skilled trade to be hired at need on salary basis.

Also very pertinent to this idea is the note carried at the top of your "Directory of Engineers," suggesting the help of an outside viewpoint to be obtained from skilled engineers in the same line of work—engineers who have no set practice or precedent to follow, or if they have they may be different and perhaps better than our own. It is especially true at this time when millions are being poured into public works through public organizations.

There is too much hurried releasing of plans for contracts without adequate study as to economic design or adaptability to purpose or location, and too much mass production of plans by the use of standards or some previous design to save time and engineering cost at an added expense of construction of eight to ten times the cost of an independent check. Very often this extra cost is incurred through improper preliminary study, expensive and costly delays. With thousands of skilled engineers who have this special training looking for work, it seems to the writer poor economy and poor public policy.

Dallas, Tex.,
Dec. 16, 1933. F. D. HUGHES.
Consulting Engineer.

ENGINEERING NEWS-RECORD

Volume 112, No. 5

Copyright 1934 by McGraw-Hill Publishing Company, Inc.

EDITOR—F. E. Schmitt. EDITORIAL STAFF—V. T. Boughton, W. G. Bowman, F. W. Herring, C. S. Hill, H. W. Richardson, W. W. De Berard, N. A. Bowers, J. I. Ballard.

Editorial and Publishing Offices at 330 West 42d Street, New York

February 1, 1934

Construction Code Near Approval

AS WE write the construction code appears to be on point of final agreement by code committee and labor, with a prospect of prompt approval by the President. In essence it is the same as the consolidated code that has been under consideration for two months and that went to the President at the close of December, only to be returned for conciliation of the labor protests. There is added a joint employer-employee National Planning and Adjustment Board which, together with its regional boards, may consider and decide any dispute or question submitted to it by consent of all interested parties—a provision that avoids any clash with the functioning of the code authority and that does effectively provide for a genuine means of adjustment of mutual problems. With this anxiously awaited development close at hand, the construction industry now definitely faces its tremendous task of effective administration of the code, to the end that sound practices may be established, confidence and stability restored, and construction placed in position to perform efficiently its service to worker, employer and public.

New Code Directives

DIFFICULTIES of administration are not the only new problem before industry. Code revision also is rising up as a new activity of the NRA, even though hundreds of codes are still in that organization's hopper. A current example of difficulties appears in the Administrator's order of last week which suspends the operation of the marketing section of the cement code in answer to protests of dealers, who demand a commission even on those sales in which they render no service. An example of the influence of law is the Connecticut injunction issued a few days ago against enforcement of the coat and suit code, on the ground of discriminatory wage-fixing in a competitive market. Questions such as these are obviously vital to the operation of industry self-government. Even larger problems loom up ahead in code revision. Fundamental questions of labor policy, of plant expansion, of production control, of price fixing must soon be decided if the NRA system is to be anything more than a debating subject. Finally, inter-industry competition is bringing up many new perplexities. The solution of all these problems is clearly the task of industry itself.

Earth-Pressure Knowledge

INSIGHT into the complexities of retaining-wall action, of a clearness far beyond anything given by past studies, is afforded by the investigations carried out with the great test-bin apparatus at Massachusetts Institute of Technology. In the first part of the work, reported in this issue, the classic case of dry granular material free from cohesion is taken up. Throughout the long history of earth-pressure study this has been the fundamental case; here, then, is the first need for a test of accepted ideas. Most briefly stated, the Cambridge tests, done by Dr. Karl Terzaghi in the Institute's department of civil and sanitary engineering, constitutes a challenge to conventional theory, for they show that the action of the earth on the wall is not definite and constant but is highly complex and variable. For example, the pressure may range from one-fourth to twice the hydrostatic equivalent of the weight of the backfill. Relative movement of the wall with respect to the backfill, or what is the same, of the backfill with respect to the wall, is the prime factor of variation. Whether the wall tilts or whether the soil becomes rearranged through vibration, traffic or weather influences, the forces acting on the wall are likely to depart far from the single static value computed by the usual formulas. As a result, proper retaining-wall design evidently is less theoretical and more empiric than is commonly thought; and, in general, higher pressures should be considered and walls made stronger.

Recognizing a Hazard

SILICOSIS as a rock-dust hazard has long been known to the mining world, but in this country, at least, the industry has preferred to ignore and belittle rather than to recognize the hazard and take steps to control it. Public health authorities and the U. S. Bureau of Mines have waged a fight against silicosis despite lack of co-operation from the mines. With this background, the American Institute of Mining and Metallurgical Engineers deserves credit for planning a special open session on rock-dust hazards for its coming meeting in New York. Silicosis is a new but very definite hazard confronting the construction industry. Construction interests are invited to attend this session, to be held on the afternoon of Feb. 19 in the Engineering Societies Building in New York City. Dust problems of mining and construction are closely related, and control remedies for one are largely applicable to the other. Close cooperation between mining and construction will aid in overcoming the rock-dust hazard common to both.

Better Structural Models

STRUCTURAL MODEL TESTING attains a new high plane by virtue of the Golden Gate Bridge tower work at Princeton University. Two modern developments combine to make the advance possible—namely, stainless-steel sheets in thicknesses of less than 0.02 in., and "shot-welding," a special resistance-welding process, which permitted the fabrication of a cellular model that is more nearly a reproduction of the actual structure than has been possible heretofore. The net result is that structural model studies are simplified and made more dependable It is also notable that because the model was an actual prototype of the structure it was susceptible of analysis by the same methods as used for the tower. Thus the design theory was subjected to direct model check, which previously has been possible only to a limited extent and by granting numerous assumptions. Any questions that may have existed as to the structural adequacy of the highly indeterminate rigid-frame towers of the Golden Gate Bridge would seem to be answerable by this procedure. The use of such a model to determine and check erection methods would seem to be a logical next step, for suspension-bridge towers undergo some of their most severe stressing during the erection period.

The CWA Crisis

CONTINUANCE of the operations of the Civil Works Administration beyond the original termination date of Feb. 15 is assured beyond question. Not only has the President called for extension of the system until May, but there is countrywide demand for keeping the four million CWA workers employed, and the sensitive ear of Congress is able to hear the demand. Many people insist that the CWA must carry on until conditions become substantially normal.

At the same time it becomes evident that reorganization of CWA operations is urgently necessary. Methods, policies and results have showed in rather glaring fashion the effects of the haste resulting from overnight initiation of the huge program. Direction of extensive maintenance-construction activities by welfare workers, widespread failure to select and lay out adequate lists of useful and feasible projects, administrative confusion that sends applicants scurrying around hither and yon or that fails to bring together materials, men and tools, discrimination in acceptance of men, lack of provision for necessary transportation and equipment, are among the symptoms of defective management. Such symptoms as well as the recently bruited charges of political interference, confusion and petty graft reflect the weakness of organizing and policy-making.

Possibly the now obvious need for a more effective organization was the motive for calling in a number of army engineers to take local charge as CWA directors, but this step is unfortunate both because it is inherently unfair and because it does not go to the root of the trouble. It casts unjustified reflection on men who have given devoted effort to the work, while the army engineers have enough to do in their own offices in carrying out the War Department's greatly enlarged program.

The root of the CWA trouble lies in the fact that in starting up a countrywide construction program of fifty millions weekly cost, reliance for its direction was placed upon welfare workers and local political officials with little or not construction experience. Under such circumstances it is not surprising to see the CWA work go against the very purpose of the recovery plan by undermining existing business. It is not surprising to see its projects trending toward regular construction and invading the field of the PWA; to see water mains and sewers laid and extensive school buildings erected by CWA labor free of cost to the citizens, or to find communities turning aside from PWA loan projects and seeking for CWA gift construction.

Engineers and contractors welcome the philanthropic purpose of the CWA movement, but they find it hard to have to pay for it in the destruction of their livelihood. That the CWA work should decimate an essential industry and bring ruin to hundreds of contractors was doubtless not contemplated, but it is a regrettable effect of the CWA's present policies and practices. The resultant setback to the recovery movement may turn out to be even more regrettable.

To make the system constructive and efficient in its operation it is plainly essential that a competent organization with wide powers of decentralized authority be set up. Men equipped by long experience for the necessary job planning and management are available; many of them indeed are the very ones who are now being injured by the CWA operations. The reasons of early haste and justified makeshift organization and methods no longer hold. If the CWA work is to be a real contribution to recovery, it is imperative that it be built into an effective operating organization and that farsighted provision be made for progressive transfer of its forces to PWA construction or to reviving industry.

Wanted—A Highway Association

THE LONG-EVIDENT NEED of a virile organization to stabilize the highway art is emphasized by last week's developments in the relation between the highway industries and the American Road Builders Association, as elsewhere reported. With its budget cut to the bone and its objectives perforce restricted to highway promotion, it is plain that the Road Builders can do little more than make a gesture of activity. Worse still, the reduction of funds is not due to depression frugality but reflects a long-growing conviction that the Association has neither the organizational structure nor the inspiration to accomplish a real task.

Laying aside all questions of past success or failure, the present fact is clear: An effective and purposeful organization of highway interests must now be developed, one that is inclusive and that will work out a positive, broadly conceived program of action for the highway field. No existing organization can serve the need, for each represents only a fractional element of the field or is organized around an individual objective. However effective these are and will continue to be in their individual spheres, the greater organization must bring together all the individual interests.

Particularly to grapple with the great problem of highway refinancing that is directly ahead, it is essential that administrative officials join with contractors and engineers, with road users and the materials and transportation men, for common action. The gasoline tax is as important as thickness of the paving slab; traffic direction is as important as sight distance or use of subgrade finishers. There is no joint meeting ground at present. An American Highway Association is needed, a self-supporting body of definite purpose whose platform is the efficient development and operation of a highway network that will best serve the public.

The need for reorganization is forced by current events. Federal donations for roadbuilding have a natural end, and that end is being hastened as federal administrators realize that in proportion as federal funds are handed out the states are diverting their road funds to other uses, and that Congress thus is merely filling the gap without adding to existing employment. The raids on road funds cannot be met by the resistance of individual militia companies; a general campaign by a mobilized highway army is necessary.

From what source shall this new army of action be recruited? The nucleus of regular troops, the long-established A.R.B.A., is disorganized to the point where morale and inspiration are all but gone. It may yet rally its forces effectively, but on present outlook the army must be created anew. Perhaps such a youthful and vigorous organization as the National Highway Users Conference will serve as rallying point. Is it prepared to broaden out to meet the needs of the situation? Can it come forward with a program? Is it willing to undertake the formidable task of bringing together highway planning, construction and operation? If the answer is affirmative, it faces a brilliant opportunity.

CURRENT NEWS

Road Builders Plan Operations on Reduced Budget

AT its convention on Jan. 22 to 25, the American Road Builders set up a reduced budget of $40,000 for its coming fiscal year's operations beginning April 1, 1934. The sources of income are a grant of $12,000 from the manufacturers division, $13,000 from association dues and other sources and $15,000 contributions by individual subscribers. The grant from the manufacturers division is to be paid one-third on April 1, one-third after three months and one-third after six months. With the reduced budget the association's work will be confined to promotion of highway improvement.

A report of the professional and technical activities of the convention is given on p. 147 of this issue. In place of the large equipment exhibit of former years the Highway Industries Association (manufacturers' division) presented an exhibit of interest and excellent appearance within the hotel where the association met. About 70 exhibitors had attractive booths showing models, samples, illustrative views and literature, also small machines and appliances. About 4,500 persons registered as visitors to the exhibits and in attendance at the sessions of the convention.

The vote for officers for the association showed the election of president, H. C. Whitehurst, director of highways, District of Columbia; vice-presidents, E. L. Benedict, Chas. M. Upham, Grover C. Dillman, and Stanley Abel; treasurer James H. McDonald and directors, Robert B. Brooks, Paul L. Griffiths, A. Lee Grover, L. B. McLeod, J. E. Pennybacker, George C. Stanley and J. Barton Weeks.

Power Commission Asks Control Over Holding Companies

The Federal Power Commission, in its annual report to Congress, urges that it be granted control over holding companies and affiliated service companies which dominate licensees developing water power sites under the federal water power act. The commission states that extension of its jurisdiction to supervisory authority over intercorporate relationships and the accounting records of companies affiliated with the commission's licensees is essential to an effective administration of the water power act. The commission states that most of the licensed projects are operated as members of holding company groups and that through the methods of intercorporate control the holding companies manage and supervise the affairs of the licensees, including the financing and construction of projects. As a result, many items claimed by the licensee as part of construction costs arise from intercorporate contracts, while the pertinent facts necessary to determine the legitimacy of such claimed items are either buried in the accounts of companies outside the commission's jurisdiction and, therefore, not subject to its scrutiny, or are not to be found in any records.

The commission reports that with funds made available to it by the Public Works Administration, it has begun its national power survey and is formulating a comprehensive program of public works pertaining to the development of water power and the transmission of electrical energy. It also is investigating the cost of the transmission of electrical energy and its distribution to consumers in the United States.

Central Valley Project Not Rejected by the PWA

The Public Works Administration has stated unofficially that the Central Valley project of California, involving an expenditure of about $170,000,000, had "in no way been rejected or adversely reported." Action by the Public Works Administration depends largely on additional appropriations.

Twin Cities Sewerage Contracts Delayed by Insurance Dispute

Call for bids on the first contract on the Minneapolis-St. Paul joint sewer system has been postponed due to the refusal of W. N. Carey, PWA engineer, to approve certain features of the specifications. The objections relate to compensation insurance and concrete aggregates.

Directors of the Minneapolis-St. Paul Sanitary District desire to make their own contract with the insurance company for compensation insurance, the premiums of which are estimated to total $450,000. The PWA objects to this method of handling insurance and has notified the board that insurance must be carried by the contractors and that the specifications must include provision that bids must include the insurance cost. Mr. Carey has also notified the board that insurance will be construed as part of the "labor and material" cost in computing the federal grant on the project.

In addition to insurance, there has been disagreement between the directors and the PWA over the material to be preferred for concrete aggregate.

Construction Code Nears Final Approval Following Discussion of Revised Draft

WITH the preparation of a revised draft of Chapter 1 of the construction industry code on Jan. 27, and discussion on Jan. 30, of the remaining points of difference between the code committee and labor representatives under this revised draft, the long pending construction code this week neared final approval by Administrator Hugh S. Johnson of the NRA and the President.

The revision adheres to the form in which the code went to the President a month ago, prior to its return to the NRA for restudy. It covers all branches or divisions of the industry in a single document, of which Chapter 1 contains the general provisions applicable to all and establishes control mechanism, while subsequent chapters contain the specific provisions applicable to individual branches, as general contracting, engineering, architecture, mason contracting, plastering, painting, etc.

Planning and adjustment board

Agreement on Chapter 1 was obtained this week, after months of negotiations, by including a provision creating a National Construction Planning and Adjustment Board of 21 composed equally of employer and employe representatives with a disinterested chairman to be appointed by President Roosevelt, for the promotion of better relations between employers and employes and the furtherance of other matters of their mutual interest. The jurisdiction of the joint board does not encroach upon the construction code authority. It has broad advisory powers and may render decisions in controversies over wages, hours and working conditions when referred by mutual consent of employers and employees.

By another provision embodied in Chapter 1 this week employers and employees in any one division of the industry may, by mutual consent, negotiate agreements to reduce the maximum of 40 hours per week stipulated by the code, for the purpose of sharing available work if it can be arranged without undue hardship on employer or employee. In case of inability to reach agreement on shortening of hours the case may be referred, with the consent of both sides, to the joint board or to regional board appointed by the joint board.

Area agreements on labor

Under the final draft hours and wages rates and other conditions of employment may be fixed for specific regions by agreements between "truly representative associations or groups of employers and employes respectively concerned, after proper notice and hearing and as a result of bona fide collective bargaining." The entire United States may be defined as a region for a particular division or subdivision of the industry. When such agreement is approved by the President its violation will become unfair competition and failure to desist a violation of the code.

In the absence of such agreements minimum wage rates are fixed at 40 cents per hour for workers and $12 to $15 per week for clerical employes; maximum hours are 40 per week or 8 per day, with specific exceptions.

General administration of the code is, as

hitherto, in the hands of a construction code authority and divisional code authorities comprising one member from each of the sponsors of the code (the Associated General Contractors are given 4 representatives) to administer and police the code, collect statistical data and study any necessary amendments. This code authority is authorized to require registration of all construction work of $2,000 or more, the fees for this registration (minimum $2) to cover the expense of administration and the expenses of divisional code authorities and construction planning and adjustment boards.

Under the code authority there are to be individual code authorities for each division. In addition a construction appeals board of 9 members is to be set up by the construction code authority to hear appeals from the decisions of divisional code authorities.

Contractor codes

As labor opposition was centered on the basic code (Chapter I), the already completed codes of the general contractors and various subcontracting groups are expected to go forward to approval together with Chapter I. Subdivisions of the general contractors' chapter, covering building construction, heavy construction and highway construction, are expected to be ready for adoption shortly.

Los Angeles Not to Negotiate Over Building of Parker Dam

The Metropolitan Water District of Southern California will not attempt any negotiations with the state of Arizona over the latter's announced intention to resist construction of a dam on the Colorado River near Parker, because the district has contracted with the U. S. Bureau of Reclamation to build the dam, according to officials of the district at Los Angeles, Calif. Arizona press dispatches announced on Jan. 24 that Gov. B. B. Moeur of Arizona, in a letter to Gov. James Rolph, Jr., of California, said he had learned that the Metropolitan Water District has procured the allotment of certain federal funds with which to initiate the construction of the proposed diversion dam which, if built, would in part be placed upon Arizona soil. He has been advised by the Arizona attorney general, Gov. Moeur said, that such a dam cannot be built without Arizona's consent. There must be, he said, an agreement safeguarding the state's proper rights and interests.

Ray Bruce of the legal staff of the water district said that the building of Parker Dam is out of the hands of the district and under the absolute control of the Bureau of Reclamation.

"The bureau has contracted with the district," Mr. Bruce said, "to build the dam, the entire cost to be repaid to the government by the district. The government will own the dam and control it. The district will have certain rights, the most important of which will be the right to divert water into the Colorado River aqueduct.

"Arizona is guaranteed many benefits under the contract, the government reserving water and power rights to be used in the development of Indian reservation and Parker-Gila project lands. The government is to secure the necessary rights of way for the dam and its construction."

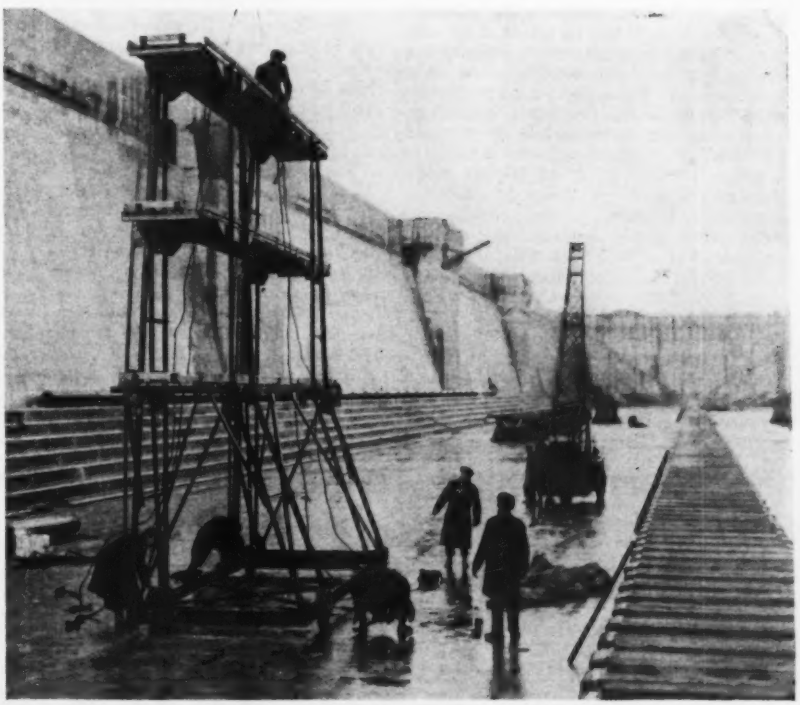
More Funds Asked For CWA—Army Engineers in Charge

AFTER appraising sentiment in Congress for continuing the Civil Works program, President Roosevelt has stuck to his decision to terminate it by May 1. In a message to Congress Jan. 27, the President requested an appropriation of $950,000,000 for direct relief and civil works. This is $100,000,000 higher than the estimate first put on these two items by the administration, but Budget Director Douglas has explained that CWA will be limited to $350,000,000 and that the additional $100,000,000 is intended for direct relief.

Army engineers in charge

One of the administration's most dramatic methods of meeting an emergency was putting CWA work under the direction of army engineers in localities where the CWA deemed it necessary to suppress graft, wipe out political influence or otherwise promote efficiency. Calling in military supervision is regarded in Washington as an attempt to lessen the attraction that CWA has for politicians who, having had little opportunity so far in this administration to dispense jobs recently discovered in the CWA, an opportunity that surpassed their wildest hopes. Assignment of Col. Daniel I. Sultan to Chicago was followed immediately by the resignation of R. J. Dunham, state civil works administrator. The resignation was held up by Harry L. Hopkins, CWA administrator, in the hope that Mr. Dunham would reconsider as "he has given a lot of devoted service to this enterprise," but later Howard O. Hunter, a CWA field worker, was appointed to succeed him. Subsequently Mr. Hunter requested and received all facilities and staff of the Illinois Emergency Relief Commission employed in carrying on CWA operations, including Frank D. Chase and the entire engineering staff and advisory board staff. Messrs. Hunter and Hopkins have offered no criticisms but have given approval of the personnel and desire no changes. The net result is that the Illinois Emergency Relief Commission withdraws and Colonel Sultan remains as director in charge of Cook county and Mr. Chase as director and chief engineer in charge of state CWA work. The resignations of Mr. Chase and staff were tendered to Mr. Dunham to do with as he saw fit and he turned them over to Mr. Hunter.

Maj. Donald H. Connolly has been assigned to Los Angeles, where indictments have been returned in 3 cases, and the assignment of other engineer officers are expected as the Department of Justice proceeds with its investigations of graft charges in 45 states. Mr. Hopkins also has ordered all state CWA administrators to open for public inspection on demand, all payrolls and records of supply purchases.



NEW DRY DOCK IN ENGLAND PUT INTO SERVICE

The great drydock recently built by the Southern Railway Co. as part of its new harbor works at Southampton, England, is completed and was put into service on Jan. 18 when the 56,000-ton S. S. Majestic was brought in for repairs. The new drydock is 1,200-ft. long, 135-ft. wide and 48½-ft. deep. The accompanying photograph shows the dock just prior to flooding it to admit the Majestic. Blocking for support of the vessel is being placed. A description of the new harbor works at Southampton was published in our issue of Nov. 23, 1933, p. 622.

Denver Approves Bond Issue For Fraser River Water Project

Denver voted its approval of the Fraser River diversion project at a special election on Jan. 23 by 23,399 for and 13,545 against. The PWA will advance about $3,500,000 to construct the project, of which $1,000,000 will be a grant. The project calls for the construction of ditches, canals, etc., for the gathering of water on the western slope of the Continental Divide at the headwaters of the Fraser River, transporting the water through the pioneer bore of the Moffat tunnel and delivering it into the South Platte river below Denver. The city then proposes to exchange this water with farmers who have water rights above Denver. Denver has leased the Moffat pioneer tunnel and owns water rights, rights-of-way and other properties. These will be deeded to the government and the latter will lease the system to the city for 30 years for annual payments that will amortize principal and interest.

The taxpayers also approved a bond issue of $1,000,000 for relief work and direct relief. Another issue of $295,000 in bonds for Cherry Creek flood control was approved and six other proposals, including $1,600,000 for the construction of a municipal sewage disposal plant, were defeated.

Bay State Commission Orders Holliston Water Improved

The Holliston (Mass.) Water Company has been ordered to provide an improved water supply for the town, following an inquiry by the state department of public utilities on its own motion. The company is seeking federal aid to enable it to comply, and the estimated cost of safeguarding the supply is about $25,000. The state board of health has found the supply threatened by pollution, the town having no sewers and the watershed being occupied by dwellings establishing a hazard to health. The supply is at present taken from a pond and from a parallel collecting ditch and chlorinated. There are 406 services. At a public hearing the company declared that it is barely able to pay its bond interest and taxes, many of its takers having stopped meeting their water bills on account of unemployment. Dr. H. D. Chadwick, state commissioner of public health, reported that reliance upon chlorination is unsafe in the circumstances and pointed out that an adequate supply can be obtained farther down the valley.

PWA to Maintain Constant Check on Material Costs

CONSTANT check on the cost of materials used in public works construction of all types is to be maintained by the PWA. For this purpose a unit known as the "Cost of Construction Material Authority" has been organized in the engineering division with A. W. Loney, a materials expert transferred from Interior Department's division of investigations, to take charge. Price records will be kept for three cities in each state and reports of market changes will be issued periodically, perhaps quarterly. These data will be used by the PWA engineer examiners in checking estimates in project applications and by the accounting and inspection divisions which must approve requisitions for allocated funds. Cost figures will be obtained from several sources. PWA state engineers are reporting prevailing prices, NRA code authorities are cooperating, and manufacturers and building exchanges have been asked to submit their price lists.

Earthquake reconstruction

An allotment of $500,000 has been made by the PWA to the Unified Rehabilitation Corp., Long Beach, Calif., a non-profit corporation, to be advanced as loans to owners of quake-damaged property. Individual loan applications must be approved in Washington and will be secured by first mortgage notes.

Post Office bids rejected

The Treasury Department has rejected all bids on the post office annex at New York because of insufficient funds. New bids have been called for Feb. 21. This will be the fourth call for bids.

State and Municipal Work

Loans and grants totaling $2,287,000 for 37 non-federal projects were approved by the Public Works Administration last week, bringing the total number to 2,118 and the amount to $870,028,704. Details are given in the accompanying table. The only large project covered is a viaduct to carry Willow Ave. over the New York Central and Erie tracks in Hoboken and Weehawken, N. J. The PWA authorized a grant of $136,000 for the project; the total cost will be $485,000.

Bond purchase contracts and grant agreements covering 1,007 of these projects have been sent out by the PWA.

The PWA has reported that it has authorized loans and grants totaling $17,542,000 to communities and private citizens that have been victims of hurricanes, fires, drought and earthquakes.

Progress on highway projects

At the end of January 5,614 highway projects had been advertised for contracts, or 67.6 per cent of the total. These total $289,958,000.

The PWA has announced the allocation of $113,000 for a road project to facilitate travel from Glacier National Park to Waterton Lakes Park in Canada, also allotment of $153,500 for the restoration of Fort Pulaski. The fort is on an island in the mouth of the Savannah River, Georgia. This money, apparently, is to be taken from allotments previously made for national park work.

Cement Code Marketing Sections Suspended Following Protests

Protests by materials dealers, state purchasing agents and others resulted on Jan. 23, in an order by Administrator Hugh S. Johnson suspending almost the entire article of the cement code relating to sales and marketing practices. The only section in the article retained relates to the computation of weights of barrels. Dealers objected to the provisions permitting direct sale to the government, to states and municipalities, to contractors on public works outside municipal limits and to central mix and block plants. State governments under the code were limited to direct purchase for specific construction projects or for maintenance work on a quarterly quotation basis, eliminating the former practice of getting bids on a year's supply on quantities seldom taken up in full. State agencies objected to these restrictions, claiming they should have at least equal rights with municipalities, which the code permitted to buy direct on a quarterly requirement basis. Illinois, which had its troubles with cement companies last spring when shopping for a year's requirement of cement, is leading the fight for the states to have these provisions revised. Missouri is also lending a strong voice of protest. Until the code administrator submits new provisions acceptable to the NRA, the cement market will be wide open to the abuses that have crippled the industry in the past few years.

DETAILS OF PWA LOANS AND GRANTS FOR NON-FEDERAL WORK

LIST NO. 46

Location	Loan and Grant or Grant	Type	Amount
Stamford, Texas	L. & G.	Water supply	$155,000
Larimore, N. K. (Increase)	L. & G.	School	4,000
McKinley, Minn.	G.	Sidewalks	4,000
Cavalier, N. D.	L. & G.	Water system	60,000
Hutchinson, Kan.	L. & G.	Drainage	30,700
Arlington, Texas	L. & G.	Dormitory	103,500
Kennett, Mo.	L. & G.	Power plant	150,000
Yerington, Nev.	L. & G.	Courthouse	40,000
Santa Rosa, Texas	L. & G.	School	6,000
Port Hope, Mich.	L. & G.	Waterworks	25,000
Montrose, Col.	L. & G.	Filtration plant	40,000
Champaign County, Ill.	L. & G.	School	362,000
Pratt, Kan.	G.	County building	6,000
Chambers County, Texas	G.	County roads	23,000
Alsey, Ill.	L. & G.	School	13,000
Elizabeth, W. Va.	L. & G.	Waterworks	70,000
Phoenix, N. Y.	L. & G.	Water meters	7,000
Interlaken, N. Y.	L. & G.	Waterworks	60,000
Matador, Texas	L. & G.	Waterworks	8,000
Crookston, Minn.	L. & G.	School	104,000
[illegible]dena, Texas	L. & G.	Waterworks and sewers	38,000
[illegible]terville, Kan.	L. & G.	School	9,000
Nowata, Okla.	L. & G.	Waterworks	21,000
Taylor, Texas	L. & G.	Waterworks	22,000
Holyoke, Col.	L. & G.	Courthouse	53,000
Maywood, Ill.	L. & G.	Reservoir	120,000
Lebanon, Mo.	L. & G.	Sewer system	124,000
Chilton, Wis.	L. & G.	School	153,000
Almont, N. D.	L. & G.	Township hall	13,000
Monett, Mo.	L. & G.	Sewage works	50,000
Santa Rosa, Texas	L. & G.	Waterworks	26,000
Chelmsford, Mass.	L. & G.	Waterworks	75,000
Tilton, Ill.	L. & G.	Village hall	16,000
State of New Jersey, Hoboken	G.	Viaduct	136,000
McLean County, Ill.	L. & G.	Storm sewer	133,000
Los Angeles, Calif. (Increase)	G.	Buildings	800
Augusta, Ga.	G.	Hospital	26,000
		Total	$2,287,000

Comptroller Holds Up Funds for Dam on Kanawha River

The district engineer, U. S. Army, Huntington, W. Va., has been notified by the Comptroller General that no funds will be made available for payment on the present contract for the construction of the Winfield locks and dam on the Kanawha River. Contract for the construction of the lock and dam was awarded to Dravo Contracting Co., Pittsburgh, in October on a bid of $1,921,130 and construction is under way. The Comptroller General holds that the Brader Construction Co., New York, underbid the Dravo Contracting Co. by $46,630 and should have received the contract.

Agreement Reached on Bridges Across Bonnet Carre Spillway

George H. Dern, Secretary of War, has announced that the long controversy between the War Department and the three railroads crossing the channel of the Bonnet Carre spillway in Louisiana has been settled and that as a result of the direct negotiations that have been going on for several weeks between the War Department and the companies, compromise settlements aggregating $4,332,736 were agreed to. The statement by Secretary Dern follows:

"The floodway channel is crossed by three railroads, these being the double track main line of the Illinois Central and the single track lines of the Louisiana and Arkansas Railway and of the Yazoo and Mississippi River Railway. These railroads must construct long pile bridges across the floodway in order that service may not be interrupted when the floodway is in operation. Negotiations with the railroads looking to the settlement of the costs of these crossings was begun in 1929. The claims of the railroads were considered excessive, and suits were therefore instituted in the District Court in June of 1930. The claims presented by the railroads to the commissioners appointed by the court aggregated $8,436,000. After protracted hearings the commissioners returned awards aggregating $6,673,057, and these awards were adopted by the court as a basis for judgment. Since the amounts were considered excessive by the War Department, appeals were taken by the United States.

"Realizing the pressing public need for prompt termination of these cases, the Secretary of War directed General Markham, the Chief of Engineers, to open direct negotiations with the companies. As a result of these negotiations, compromise settlements aggregating $4,332,736 were agreed to, a saving to the United States of $2,340,321, with the agreement that these funds would be at once applied to the construction of the bridges. The fair and constructive attitude of the railroad companies in these negotiations merits commendation. Through the prompt action of the Department of Justice, interlocutory decrees in favor of the United States have been entered, the awards have been deposited with the Court, and when the individual parties to the action have been served, the entire matter will be closed and final decrees entered.

Timber Preservation And Uses Discussed At Houston Meeting

THE American Wood-Preservers Association held its thirtieth annual convention in Houston, Texas on Jan. 23-25. Representatives of the wood preserving departments of most of the railroads were present as well as those representing the commercial treating plants.

A paper prepared by Sir Ralph S. Pearson, late director, Forest Products Research Laboratory, England, was read. It reviewed the history, evolution and present lines of development of wood preservation in Great Britain. There has been a large increase in the use of treated timber by the large land owners of that country in recent years, and at least 41 estates are known to be operating pressure plants, ranging in size from 12 ft. 6 in. to 21 ft. cylinders. The majority of these plants use creosote. Other large estates are equipped with open tanks and 85 such plants are reported.

The successful use of creosote piling and structural timber in the many marine structures along the Gulf coast was described by J. F. Coleman of New Orleans, La. He urged further research on the part of the wood preserving industry, and recommended that when any change is made from specifications used with success over a period of years, that such changes be made only at the direction of those in authority and with a full knowledge of what is being done and why.

Joint session on termites

At a joint session attended by the Houston Engineers' Club, South Texas Chapter American Institute of Architects, Rice Engineering Society, Hermann von Schrenk, consulting timber engineer, St. Louis, gave a very instructive talk on termites and methods of combating them, which was followed by a movie film entitled "Termites." Dr. von Schrenk suggested that while termites are one of the oldest types of social insects, that they seemed to have developed extraordinary activity in the last few years and that there are very few areas in the U. S. A. which are not effected by them to some extent. He cautioned against the widespread alarm about the possible damages which have been attributed to termites and stressed the need for intelligent study on the part of engineers and architects in the design of buildings, citing many cases wherein termite damage had occurred in buildings in which concrete had been used for foundations, yet termites had gained entrance due to cracks or seams in the concrete. Reference was made to outstanding contribution to our knowledge of termites in this country by the Termite Investigations Committee of California, whose findings have just been published.

New types of creosote

New types of creosotes received considerable attention, and new ways to measure the effectiveness of creosotes were presented. J. A. Vaughn, research engineer, Southern Wood Preserving Co., Atlanta, Ga., presented a paper on creosote plus phosplatide for the production of non-bleeding creosoted southern pine poles. There has been an ever-increasing demand on the part of the public utilities for clean poles, and the work done by Mr. Vaughn is an attempt to lower the viscosity and surface tension of creosote and to reduce the interfacial tension between the oil and any water with which it comes in contact. This result is said to be obtained by adding phosplatide (lecithin). The process is being patented in the United States and is already patented in Canada. Poles are being commercially treated by this process at the present time.

Weathering of creosote

A paper on the weathering of creosote by means of a new accelerater test developed by professors Gillander and King of the University of Pittsburgh in collaboration with the Koppers Products Co. of Pittsburgh was presented by E. O. Rhodes, of the Koppers Products Co. Four functions are measured, (1) fugus resistance, (2) permanence of the oil, (3) toxicity of the residium oil, and (4) the distilling range of the extracted residiums. The data obtained from these tests are designed to help to evaluate the toxicity-permanence values of various high and low boiling creosotes, and what may be expected from their use over a long period of time.

A nine weeks cycle in the testing machine is designed to approximate actual weathering conditions for many years of actual service. The tests are made on wood treated with various creosotes. The test pieces, approximately ½"x½"x3", are subjected to an air blast to induce ordinary evaporation, then pass to a heated chamber, carrying a heat of 62°C, and finally are submerged in water, to induce the leaching effect of water soluble constituents.

New trestle design

The Southern Pacific Railroad exhibited their latest standard open deck wooden pile trestle design, which is said to show a saving of nearly 25 per cent, over their former standards. From the wood preserver's angle, this new design is most satisfactory, because practically all boring and framing is done before treatment. Two full sized spans were erected in the wood preserving plant yard, which showed in details the various construction details. No drift bolts are used. Instead a steel plate is applied to the underside of the cap to which are welded small-section angle irons to hold the piles in place. Straps bolted to the cap and to the pile hold the caps in place. A considerable part of the saving claimed for this design comes from having the materials prefframed at the treating plant. Further the method allows all framed parts to be thoroughly pressure treated, which from experience has proven most necessary.

Pole creosoting

R. E. Meyers, of the International Creosoting and Construction Co., of Galveston, Texas reviewed the latest developments in creosoted poles, crediting the American Standards Association with having done much in the past year to put pole practice and pole size on an

engineering basis. He also referred to the growing practice of injecting four pounds of creosote into poles, to make safe storage possible over a greatly extended time. When shipping orders come, the poles are framed to meet the special framing required by the customer, and then treated with an additional four pounds of creosote *after framing.*

In the earlier specification for poles, it was usual to specify twelve pounds of creosote per cubic ft. Today, eight pounds final retention is used almost everywhere. Improved seasoning methods and technical control result in getting much deeper penetration than did the twelve pound treatment of a decade ago. The value of deep penetration is being recognized more and more, and lack of uniformity in penetration is regarded as an evidence of improper seasoning and conditioning. A steam bath for poles after the completion of the preservative treatment is now regarded as good practice to obtain clean poles. It was stated that there is a possibility that "bleeding" of creosote from poles depends somewhat on the kind of creosote used.

A recent development in the manufacture of poles is the introduction of a pole shaving machine into this country from Germany, where it has been used quite generally. This pole shaving machine shaves the pole over its entire length, trimming the knots, and when finished the pole has almost the appearance of a piece of tapered iron pipe. It is likely that machine shaved poles will generally supplant hand shaved poles in this country as had already been the case in Germany.

The ability of pine poles to withstand excessive storm strains, due to the great flexibility of this species of wood was stressed. Also the fire resisting qualities of creosote poles as evidenced in a great many instances was cited. The use of fabricated creosoted pine towers over 300 ft. high at radio stations was cited as an example of the successful substitution of creosoted wood employing the reinforced connector-constructor, in a field heretofore held by steel.

Next year's meeting is scheduled to be held in New York, and S. R. Church, consulting engineer of New York, was elected president to succeed R. S. Belcher, manager of treating plants, A. T. & S. F. Ry.

Mining Engineering Society Plans Special Session on Silicosis

The American Institute of Mining and Metallurgical Engineers will hold a special session on mineral dust hazards and silicosis at the 143rd. meeting of the Institute in New York Feb. 19-22. This meeting, open to the interested public, will take place at 2 p.m., Feb. 19, in the Engineering Societies Building auditorium. B. F. Tillson, consulting engineer, will preside. Topics to be presented include: Cost of vocational hazards of mineral dusts to industry, pathological researches with mineral dusts, comparison of dust sampling and counting methods, dust problems in rock drilling, and diagnosis of silicosis. An exhibit of various dust sampling and dust disease preventative equipment will accompany the meeting.

Large Fund Proposed To Be Loaned for Home Modernization

ANNOUNCEMENT by President Roosevelt that plans are under consideration to make $250,000,000 available as federal aid in home renovizing was followed on Jan. 29 by the statement from John H. Fahey, chairman of the Home Loan Bank Board that the board is prepared to recommend 3 methods. First, by expanding the credit resources of private home-financing institutions by increasing the volume of funds available through membership in the federal home loan bank system; second, by active development of the Federal Savings & Loan Associations in communities where home financing resources are insufficient; and third, by enabling the Home Owners Loan Corporation, which deals only with home owners in difficulty with their present mortgages, to finance desirable improvements on homes on which it makes these emergency loans.

"The Home Loan Bank Board is strongly opposed to artificial stimulation of home construction," said Mr. Fahey, "but with recovery under way, thousands of home owners are now ready to undertake long postponed alterations, provided they can obtain mortgage credit. That barrier to home betterment and to greater industrial activity must be promptly removed. No other step would bring greater immediate benefit to large numbers of home owners, and to the millions of workers normally employed in the building industries."

Legislation being drafted

After a conference with Budget Director Douglas on Jan. 30 Mr. Fahey announced that amendatory legislation now is being drafted to enlarge the scope of the board's operations. No direct appropriation will be requested as funds are available through the Treasury and RFC. The board has studied numerous plans proposing direct loans by the federal government to home owners for construction and modernization, but Mr. Fahey said the board is opposed to direct loans as involving too many complications and inviting graft. The board does not wish to compete with private home financing institutions but to expand their credit resources to meet a probable shortage in private capital. It is the board's intention to promote establishment of federal savings and loan associations by asking Congress to raise the present limit of $100,000 on stock subscriptions by the government on a share-for-share basis.

The volume of demand for new home construction is described by Mr. Fahey as a highly controversial subject. The board recognizes that there may be an actual shortage of homes in some localities but questions the estimate of 750,000 to 800,000 made in a recent study by the NRA research staff.

Contracts Let for Levee Work

Colonel Harley B. Ferguson, president of the Mississippi River Commission, on Jan. 23, approved 7 contracts totalling $1,703,236 for levee work in New Orleans, La., District No. 2.

SOCIETY CALENDAR

CONSTRUCTION LEAGUE OF THE UNITED STATES, annual meeting, Willard Hotel, Washington, D. C., Feb. 1-2.

ENGINEERING INSTITUTE OF CANADA, 48th annual general meeting, Montreal, Que., Feb. 8-9, 1934.

AMERICAN CONCRETE INSTITUTE, Toronto, Ontario, Canada, Feb. 20-22, 1934.

AMERICAN RAILWAY ENGINEERING ASSOCIATION, Chicago, Ill., March 12-14, 1934.

AMERICAN WATER WORKS ASSOCIATION, annual convention, New York, June 4-8, 1934.

SMOKE PREVENTION ASSOCIATION, annual convention, June 19-22, Buffalo, N. Y.

AMERICAN SOCIETY FOR TESTING MATERIALS, Atlantic City, N. J., June 25-29, 1934.

SAN DIEGO SECTION, American Society of Civil Engineers, at its recent annual meeting, elected H. A. Noble, president, Fred D. Pyle, vice-president, and L. L. Mills, secretary-treasurer.

THE COLORADO SOCIETY FOR ENGINEERS has elected Frank H. Prouty president, R. J. Tipton, vice-president, and C. M. Lightburn, secretary.

SEATTLE SECTION, American Society of Civil Engineers, has elected Rear Admiral Luther E. Gregory (retired) president, R. M. Murray, vice-president, and Miles H. Clark, secretary-treasurer.

OHIO ENGINEERING SOCIETY will hold its annual convention at the Neil House, Columbus, Feb. 6-8.

Brief News

CONSTRUCTION OF A HIGHWAY to the site of the Grand Coulee Dam in Washington is provided for in a bill signed recently by Governor Martin appropriating $750,000 for the work.

GRADE CROSSING ELIMINATION PROJECTS under consideration in many states are listed in a special report on highway crossings (January, 1934) published by the American Institute of Steel Construction, New York. The report gives Interstate Commerce Commission statistics as to the number of grade crossings in the country, the approximate number of crossings needing to be eliminated and crossing accident statistics.

FUNDS SUFFICIENT TO FINANCE continued Colorado River aqueduct construction for the ensuing six months were assured Jan. 20 when the board of directors of the Metropolitan Water District of Southern California accepted a bid from the Reconstruction Finance Corporation on a $8,064,000 block of the district's bonds. The sale brings the total amount of aqueduct bonds disposed of to date to $22,176,000. All bonds have been sold to the R.F.C., and bear interest at a rate of five per cent.

HEARING ON A CODE of fair competition for the water supply industry is to be held in Washington on Feb. 6. A code has been submitted by the Institute of Water Supply Utilities, Inc., a new organization stated to represent 65 per cent of the industry. It provides for an average work week of 40 hours in cities over 250,000 population, 48 hours in smaller communities down to 2,500 population and no limitation below that. Minimum wages are fixed at 40 cents an hour for employees on piece work and from $15 to $12 per week, depending on the size of the community.

Personal

GORDON D. WHITE, Denver, has been named resident engineer for the Public Works Administration's project at Pueblo, Colo.

B. O. COOPER, formerly with the engineering staff of East St. Louis, has been named engineer for the East St. Louis Park Board's Lake Park project.

EDWIN H. PLATT, Sheridan, Wyo., has been appointed assistant state engineer for Wyoming to fill the vacancy caused by the transfer of WALTER P. SMYTH to other state work.

ALLYN R. JENNINGS, formerly engineer for the Grand Island Committee of the State Council of Parks, Buffalo, has been appointed director of planning of the park department of New York City. He has been succeeded by GEORGE E. UNGER.

JAMES R. WERTH has been appointed engineer-inspector for the Federal Public Works Administration on the construction of the diesel engine electric plant to be constructed for the town of Culpepper, Va. Formerly Mr. Werth was commercial manager of the Sao Paulo, Brazil properties of Electric Bond & Share Co.

GEORGE J. RAY, chief engineer of the Delaware, Lackawanna & Western R.R., recently was promoted to be vice-president and general manager. He was succeeded as chief engineer by G. A. PHILLIPS, former chief engineer of maintenance of the Lehigh Valley R.R.

BURNETT P. MCWHORTER, former state highway engineer at Atlanta, Ga., has been appointed senior highway design engineer for the 8th District of the U. S. Bureau of Public Roads with headquarters at Montgomery, Ala. The district comprises Alabama, Georgia, Tennessee, Mississippi, Louisiana, South Carolina and Florida.

HARRY W. ALEXANDER, engineer and secretary of the City Planning and Zoning Commission, Louisville, Ky., has resigned as project officer for the Civil Works Administration in Louisville and Jefferson County. Recently he was presented the annual distinguished service award of the Junior Chamber of Commerce for his service as project engineer.

Obituary

WARREN C. CALLAHAN, assistant chief engineer on the construction of the Columbian Exposition at Chicago, died at his home in Louisville, Ky., on Jan. 22, age 77 years.

JOEL A. THAYER, for nearly 25 years superintendent of streets at Tauntion, Mass., died at his home in that city Jan. 23. Mr. Thayer was born in Taunton 59 years ago and had been engaged in highway construction during his entire career.

FRANK A. FURST, former chairman of the board of the Arundel Corp., Baltimore, died at his home in Baltimore on Jan. 23, age 88. Mr. Furst's connection with the construction industry began in 1890 when he acquired an interest in a small dredging company. Subsequently he became president of the Baltimore Dredging Co. and of the Maryland Dredging & Contracting Co. He was connected with the construction of the Cape Cod Canal, the Philadelphia Navy Yard and the Everglades drainage work in Florida.

CONSTRUCTION STATISTICS OF THE WEEK

HIGHER private awards are not sufficient to offset the drop in public contracts for heavy engineering construction this week. Total engineering construction is $16,655,000, a drop of 26 per cent from last week. Both federal awards and highways are way down, the former 2.2 millions compared with 7.9, 9.7, 4.4 and 9.9 millions in preceding weeks, and highways at 5.0 compare with 7.1, 7.2, 15.9 and 9.4 millions in the preceding weeks of this year. This combination causes a 39 per cent drop in public awards from last week and a 48 per cent drop from the previous 4-weeks' average. Private work increased from 4 millions to 5.4 millions. This week's total compares with 4.0, 2.8, 4.8 and 2.5 millions for private awards in preceding weeks.

Large contracts include Delaware River Joint Commission award for the high speed line over the Philadelphia Camden bridge, $998,394; a department store in Chicago, $1,500,000; elevators for the federal court building in New York, $609,600. The largest highway awards for the week were by Connecticut, $506,000; California, $463,000 and Illinois, $442,000.

PWA allotments dropped to $2,288,000, while municipal bond sales increased to $12,122,000, almost double the previous week's high. This total, however, includes $8,064,000 in bonds of Metropolitan Water District of Southern California which were bought by the RFC. Announcement by the PWA of bond contracts executed are now coming through from Washington, evidence that the work from municipal and state allotments may shortly be accelerated. The municipal bond market is stiffening up. Yields have dropped and a scarcity of prime issues is reported. The *New York Times* reports that the advance in municipal bond prices from Jan. 1 to Jan. 23, was the greatest recorded in so short a period and set a 40-year mark.

CONTRACTS
(Thousands of Dollars)

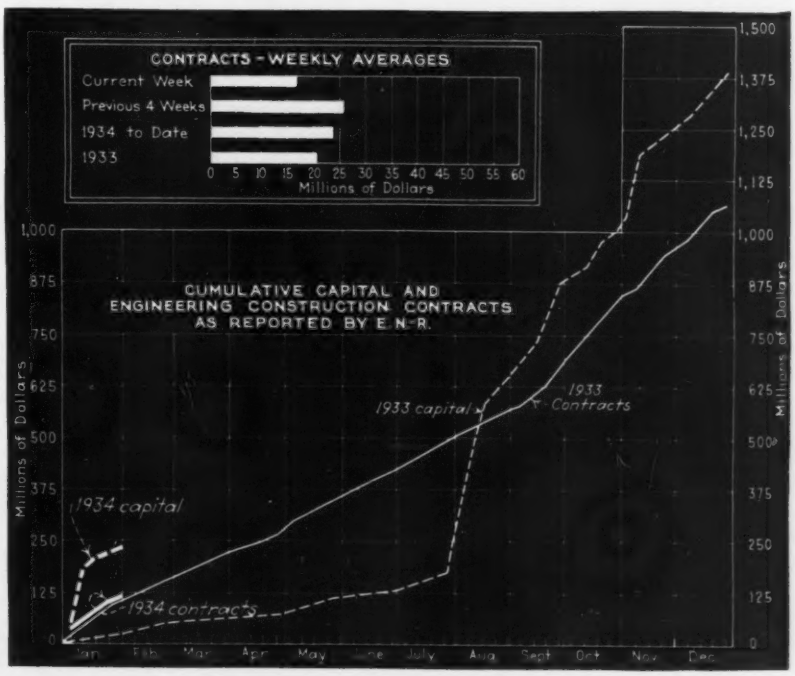
	Weekly Average Feb. 1933	Prev. 4 Weeks	Week Feb. 1 1934
Federal Government	$3,737	$7,976	$2,150
State and municipal	5,873	13,878	9,149
Total public	$9,611	$21,853	$11,299
Total private	5,517	3,542	5,356
Week's total	$15,128	$25,395	$16,655
Cumulative to date:			
1933	$116,683	1934	$118,236

NEW PRODUCTIVE CAPITAL
(Thousands of Dollars)

1934	Week Feb. 1	Cumulative
State and municipal	$12,122	$26,441
PWA allotments, S&M	2,288	173,235
Corporate issues	146	3,051
PWA allotments, private	....	36,024
Total, Non-Federal	$14,556	$238,751
PWA allotments Federal Constr.	.....	44,934
Total new capital	$14,556	$283,685
Cumulative total to date:		
1933	$25,200	1934 $238,751
Rescinded or reduced allotments (from 1933 PWA totals)		$32,502

INDEX NUMBER

E.N.-R.-Cost		E.N.-R.-Volume	
February, 1934	194.04	January, 1934	113
January, 1934	191.26	December, 1033	116
January, 1933	159.30	January, 1933	129
1933 (Average)	170.28	1933 (Average)	102
1932 (Average)	156.97	1932 (Average)	127
1931 (Average)	181.35	1931 (Average)	220
1913 (Average)	100		



Business Side of Construction

Construction Ahead of Year Ago; Cost Index Again Rises

HEAVY engineering construction contracts awarded in January exceeded January a year ago by six per cent in dollar value. The total for the four weeks is $101,581,000 or a weekly average of $25,395,000. This is slightly below the December average of $25,641,000. Public work totalled $87,413,000, 86% of the total, with private work at $14,168,000. Weekly averages are $21,853,000 for public and $3,542,000 for private construction. Private work in January was 57% below the December total.

Due principally to new labor rates effective in February the *Engineering News-Record* Cost Index rose to 194.06. An adjustment in the cement price accounted for a very small part of this rise from 191.26 and increases in labor at Birmingham and Philadelphia, with stabilization in New York at the higher rate quoted for heavy construction common labor, slightly offset by the adoption of the same rate for building construction common labor as for heavy construction, accounted for the rest of this rise.

Highway lettings averaged 9.9 millions per week. This was higher than the September and December averages of 9.2 millions and under the November average of 10.3 millions. Waterworks and sewerage have not yet started to reflect to any substantial degree the increased activity in contract awards due to PWA allotments. Federal awards totalled $31,903,000 and state and municipal $55,510,000 compared with $20,529,000 and $48,966,000 respectively in December. These are both ahead of January last year while the private contracts are below. Public buildings are about the same, industrial buildings below and commercial buildings slightly ahead of a year ago.

Geographically New England, the South, the Middle West and West of Mississippi are running ahead of last year on contract awards with Middle Atlantic and Far West below last year's January totals. Lock and dam work and other waterway and flood control work totalled $4,963,000 in the Middle West District, and $4,245,000 in the area West of Mississippi. Highways totalling $10,675,000 pushed the West of Mississippi total up to the high for all territories, $27,055,000, compared with $17,793,000 in the South and $17,562,000 in Middle West.

Materials notes

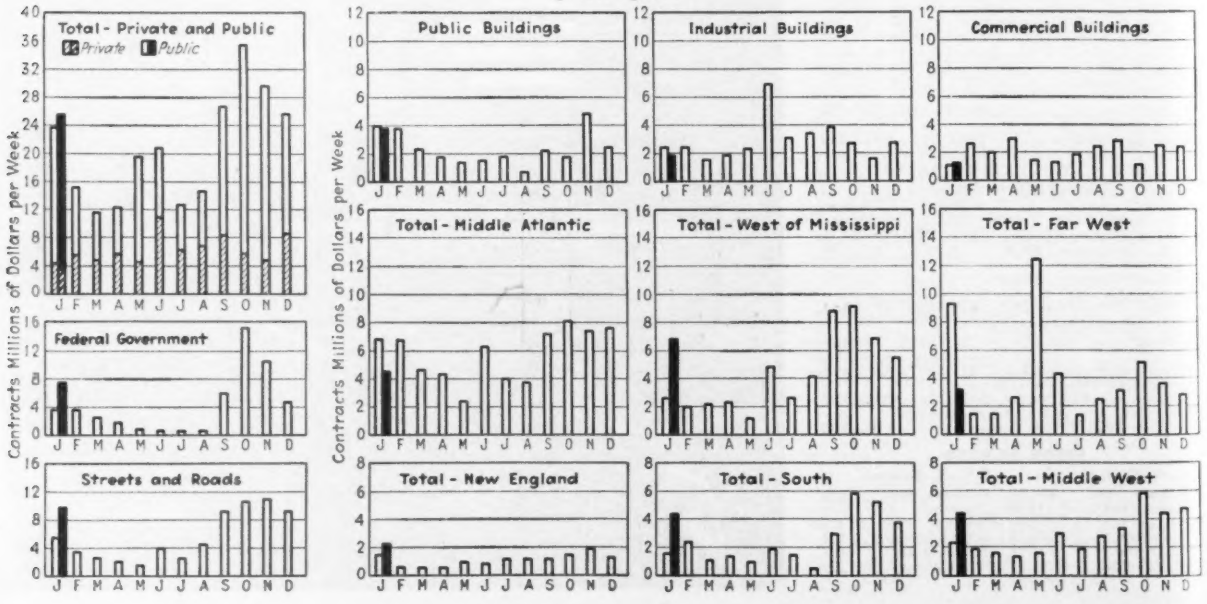
Cement—Portland cement production in December, 1933 totalled 3,526,000 bbl. compared with 4,248,000 bbl. in 1932 and 4,672,000 bbl. in November, 1933. Shipments from the mills were 3,738,000 bbl. in December compared with 2,835,000 bbl. a

ENGINEERING CONSTRUCTION CONTRACTS REPORTED IN JANUARY, 1934

Four Weeks — Thousands of Dollars (000 Omitted)

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	—United States— Jan. 1934	Jan. 1933	Canada Jan. 1934
Public Works									
Waterworks	521	77	77	196	760	138	1,769	20,614	137
Sewers	234	1,375	115	437	296	6	2,463	2,470	181
Bridges, public	3,058	524	268	445	2,339	2,196	8,830	4,647	230
Earthwork and waterways	58	2,783	3,777	4,963	4,245	1,665	17,491	11,667	....
Streets and Roads	2,645	4,984	8,911	6,516	10,675	5,880	39,611	21,716	40
Buildings, public	253	3,123	2,675	1,339	7,106	347	14,843	15,771	125
Unclassified, public	209	214	640	28	455	860	2,406	898	....
Total public	6,978	13,080	16,463	13,924	25,876	11,092	87,413	77,783	713
Federal gov't (included in other classifications)	1,603	4,630	7,448	5,116	6,856	4,474	30,127	14,545	....
Private									
Bridges, private	....	347	40	85	110	.....	582	1,032	....
Buildings, industrial	808	1,097	944	3,488	241	780	7,358	9,425	140
Buildings, commercial	805	3,555	166	....	100	357	4,983	4,273	303
Unclassified, private	16	103	180	65	728	153	1,245	2,879	....
Total private	1,629	5,102	1,330	3,638	1,179	1,290	14,168	17,609	443
January, 1934 (4 weeks)	**8,607**	**18,182**	**17,793**	**17,562**	**27,055**	**12,382**	**101,581**	**95,392**	**1,156**
December, 1933 (4 weeks)	5,072	30,348	15,352	18,710	21,845	11,236	.....	102,563	2,470
January, 1933 (4 weeks)	6,106	27,353	6,343	8,640	10,453	36,497	.....	95,392	802

CONTRACTS REPORTED—WEEKLY AVERAGES—1933-1934



year ago and 4,463,000 bbl. in November. December production figures represent a decrease of 17 per cent from last year, while shipments for the same period were 32 per cent higher than in December, 1932. Stocks at the mills at the end of 1933 were 3.7 per cent lower than at the close of 1932. Preliminary totals for 1933 show decreases of 17.4 per cent in production and 20.7 per cent in shipments from final totals reported for 1932. Production was 23.6 per cent of capacity in December, 1933 compared with 28.3 per cent of capacity in 1932.

Steel—The operating rate of steel companies having 98.1 per cent of the steel capacity of the industry as reported by American Iron and Steel Institute will be 34.4 per cent of the capacity for the week beginning Jan. 29, compared with 32.5 per cent one week ago and 29.3 per cent one month ago. This represents an increase of 5.8 per cent over last week.

Lumber—Lumber orders received at the mills during the week ended Jan. 20, were heavier than those booked during any week of the previous three months with the exception of the three-week spurt in November and were greater by 26 per cent than those of the preceding week; production and shipments were above those of the preceding three weeks, according to the National Lumber Manufacturers Association. Reports from 1,185 American mills, show production 145,461,000 feet; shipments, 135,865,000 feet; orders, 169,608,000 feet.

Carloading Forecast—The Regional Shippers' Advisory Board's national forecast for the first quarter of 1934 estimates an increase in carloadings of 11.3 per cent for sand, gravel and stone; 19.2 per cent for lumber and forest products; 20.8 per cent for iron and steel; 23 per cent for brick and clay products; 9.8 per cent for cement and 4 per cent for lime and plaster.

Labor notes

Temporary work under CWA, PWA and CCC is employing 4,600,000 men, according to the January report of the American Federation of Labor. To this employment total is added 1,800,000 who were out of work last year but now have jobs in industry.

On construction, skilled labor rates in Birmingham have advanced to $1.00 per hour for bricklayers, carpenters, structural iron workers and plasterers, and $1.12½ per hour for hoisting engineers. Common labor is 30c. per hour. In Philadelphia the top skilled labor rates have dropped from $1.50 to $1.00 for bricklayers, from $1.00 to 75c. for carpenters, from $1.37½ to $1.15 for structural iron workers, from $1.67 to $1.00 for hoisting engineers, from $1.37½ to $1.00 for plasterers and the top for common labor has increased from 40c. to 50c. per hour. In New York skilled and heavy construction common labor rates have stabilized at the higher figure in the previous range and the common labor rate for building has dropped from 93¾c. to 82½c. The *EN-R* compilation of average common construction wage rates rose from 51.58c. Jan. 1 to 52.68c. Feb. 1 and the skilled average construction wage rates rose from $1.054 to $1.062.

The Department of Labor's general index of the cost of living for families of wage earners registered an increase of 5.2 per cent during the 6 months' period ending December, 1933. In this same period the *EN-R* average of skilled labor on construction increased 7% and the average of common labor on construction increased 16½%.

Rochester, N. Y.—Three contractors discontinued work on two building projects as a result of differences between contractors and Masons, Plasterers and Tilelayers Union 11 over the new wage scale. The union has set up a scale of $1.50 per hour and a 30-hour week. This action affected 55 men on the state building project and 15 men on the post office building. The old scale is $1.12½ per hour.

Sacramento, Calif.—State highway work involving projects in northern California totalling $2,353,000 in which bids have been opened or advertised was held up pending outcome of litigation in San Francisco to determine whether wage scales in certain California Recovery Act codes superseded the prevailing wage law. Suit was instituted by the Building Material Drivers Union and the Steam Shovel and Dredger Men's Union who have wage codes for the northern part of the state and a 30-hour week which do not correspond with hours of labor of other crafts on the jobs involved in the affected work. Work in the southern part of the state is not affected. Two bridge jobs in Sacramento will be seriously affected if work is not resumed at an early date in order to complete substructures during the period of low water.

Kansas City, Mo.—The strike called because J. A. Davis Transfer Co. employed non-union truck drivers to haul brick to the new Jackson County courthouse construction ended Jan. 24. Strike was called by representatives of organized labor over the formation of a local unit of the International Brotherhood of Teamsters, Chauffeurs, Stablemen and Helpers. Work was resumed on construction operations but hauling of brick had not been resumed, whether due to a supply on the job or because the labor question had not been solved was not announced.

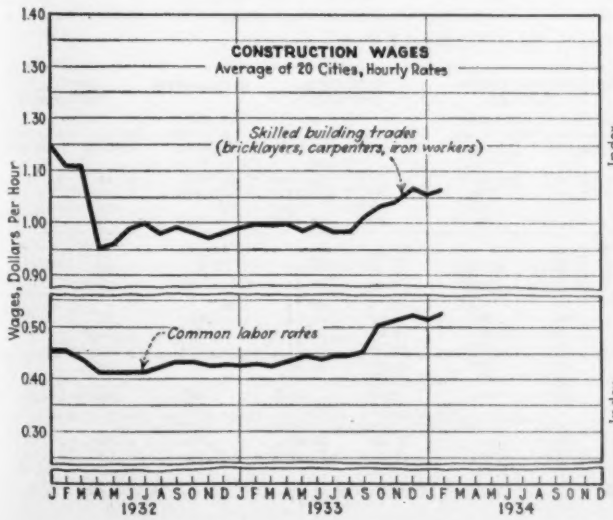
EN-R Cost and Volume Index

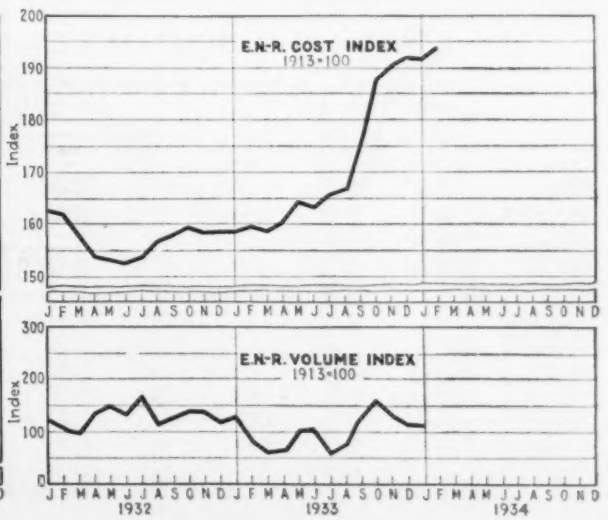
The *Engineering News-Record* Construction Cost Index for February stands at 194.06, as compared with 191.26 for the previous month. The rise in the cost index this month is due to an adjustment in the cement price and increases in common labor at Birmingham and Philadelphia. Also the New York rate for common labor stabilized at 82½c. for both heavy construction and building. This month's Cost Index is 21.8 per cent over the corresponding index a year ago.

The *Engineering News-Record* Construction Volume Index for January is 113, slightly lower than last month due in part to lower contract awards and in part to the higher cost index. The index compares current "real construction" with corresponding volume in 1913. When the cost index is up the volume index, being a function of both cost and dollar volume, is relatively lower than the statistics representing dollar volume. Thus dollar volume of engineering construction in January, 1934, is six per cent over 1933 whereas due to an increase in the cost index from 159.30 to 194.06 the volume index is 12 per cent below a year ago.

INDEX NUMBERS

E.N.-R.-Cost		E.N.-R.-Volume	
February, 1934	**194.06**	**January, 1934**	**113**
January, 1934	191.26	December, 1933	116
February, 1933	159.30	January, 1933	129
1933 (Average)	170.28	1933 (Average)	102
1932 (Average)	156.97	1932 (Average)	127
1931 (Average)	181.35	1931 (Average)	220
		1913 (Average)	100





CURRENT PRICES OF CONSTRUCTION MATERIALS

CEMENT, AGGREGATES AND READY-MIXED CONCRETE

	PORTLAND CEMENT — Per bbl., carload lots, f.o.b. city, including cost of bags			SAND AND GRAVEL — Per ton, carload lots, f.o.b. city			CRUSHED STONE — Per ton, carload lots, f.o.b. city		CRUSHED SLAG — Per ton, carload lots, f.o.b. plant		CONCRETE — Ready Mixed 1:2:4, 50c.y. or more, delivered
	Cloth Bags*	Paper Bags	Bulk	Gravel, 1½ in.	Gravel, ¾ in.	Sand	1½ in.	¾ in.	1½ in.	¾ in.	
Atlanta	$2.92	$2.67	$2.67	$1.90	$1.90	$1.45	$1.60	$1.60	$1.60	$1.60	$8.00
Baltimore	2.71	2.46	2.26	1.80‡	2.00‡	1.25‡	1.80‡	1.80‡	2.25	2.25	7.75
Birmingham	2.55	2.30	2.05	1.75	1.75	1.40	.....	.....	.90	1.15	5.20
Boston	2.72	2.47	2.27	1.50	1.50	1.10	1.50	1.50	.....	.....	6.50
Chicago	2.85‡	2.60‡	2.00	2.50†	2.50†	2.25†	2.50†	2.50†	.....	.....	.....
Cincinnati	2.52	2.27	2.07	1.30	1.30	1.20	1.80	1.80	.....	.....	6.70
Cleveland	2.50	2.25	.....	1.50	1.50	1.45	1.55	1.55	1.75	1.75	7.85
Dallas	2.50	2.25	2.05	1.90	1.90	1.75	1.80	1.90	.....	.....	6.25
Denver	3.60‡	3.40‡	.....	1.85	.....	1.25	.....	.....	.....	.....	.....
Detroit	2.25	2.00	1.80	1.15	1.05	.85	.85	.85	.90	.90	5.75
Kansas City	2.95	2.65	2.25	.65	.65	.65	1.00	1.00	.....	.....	7.50
Los Angeles	2.90	2.65	.....	1.90	1.90	1.40	1.90	1.90	.....	.....	6.70
Minneapolis	2.75	.....	2.30	1.00	1.00	.25	1.00	1.00	.....	.....	7.00
Montreal	.....	1.70	.....	.....	1.50	1.35	.....	1.25	.....	.....	.....
New Orleans	2.52	2.27	.....	1.70	1.70	1.40	.....	.....	.....	.....	7.75
New York	2.90‡	2.65‡	.....	1.50†	1.50†	1.00†	1.75†	1.85†	.....	.....	8.00
Philadelphia	2.55	2.30	.....	2.00‡	2.25‡	1.80‡	1.75‡	2.00‡	1.75‡	1.75‡	6.84
Pittsburgh	2.50	2.25	1.65	1.50‡	1.50‡	1.70‡	2.25‡	2.25‡	1.25	1.25	8.25
St. Louis	2.47	2.22	.....	1.95‡	1.50‡	1.65‡	1.75‡	1.75‡	.75§	.75§	7.20
San Francisco	2.37	2.17	1.87	1.75	1.75	1.75	1.65	1.65	.....	.....	7.00
Seattle	2.90	2.65	.....	1.50†	1.50†	1.50†	.....	.....	.....	.....	5.75

*Includes 40c. per bbl. for bags, 10c. allowed for each returnable bag. †Per cu. yd. ‡Delivered. §F.o.b. Granite City, Ill.

CURRENT MILL PRICES CEMENT TO DEALERS, CARLOAD LOTS, F.O.B. MILL

Charge for bags not included. For cloth bags, add 40c. per bbl.; 10c. refund allowed for each returnable bag; for paper bags add 15c. per bbl., not refundable.

	Bagged	Bulk		Bagged	Bulk		Bagged	Bulk
Alpena, Mich	$1.65	$1.60	Ironton, Ohio	$1.60	$1.55	North Birmingham, Ala	$1.75	$1.70
Buffington, Ind	1.60	1.55	Iola, Kans	1.70	1.65	Richard City, Tenn	1.85	1.80
Crestmore, Calif	1.72	.....	La Salle, Ill	1.60	1.55	Saginaw, Mich	1.65	1.60
Dallas, Tex. (Inc. 5c. tax)	1.80	1.75	Limedale, Ind	1.60	1.55	Steelton, Minn	1.80	1.75
Hannibal, Mo	1.60	1.55	Mason City, Ia	1.70	1.65	Universal, Pa	1.65	1.60
Hudson, N. Y	1.75	1.70	Norfolk, Va	1.76	1.71	Waco, Tex. (Inc. 5c. Tax)	1.80	1.75
Independence, Kans	1.70	1.65	Northampton, Pa	1.65	1.60	Wyandotte, Mich	1.60	1.55

STRUCTURAL CLAY BUILDING TILE, BRICK AND LIME

	STRUCTURAL CLAY TILE — PARTITION — Per M, lots of 2,000 pieces or over, delivered			STRUCTURAL CLAY TILE — LOAD BEARING — Per M, lots of 2,000 pieces or over, delivered			BRICK — Per M, in quantity, delivered		LIME — Per ton, in paper, carload lots, delivered		
	3x12x12 in.	4x12x12 in.	8x12x12 in.	8x12x12 in.	10x12x12 in.	12x12x12 in.	Common backing	Straight hard	Hydrated finishing	Common hydrated	Pulverized or lump
Atlanta	$75.00	$95.00	$160.00	$208.40	$243.20	$277.90	$14.50	$14.50	$19.00	$13.00	$13.00
Baltimore	75.00	77.00	145.00	165.00	200.00	240.00	14.00	15.00	16.00	14.00	18.00
Birmingham	84.25	90.00	156.00	180.00	215.00	242.00	15.00	22.50	3.00§	1.75§	2.25§
Boston	99.00	105.00	197.00	209.90	258.40	295.00	14.00	16.00	19.00	15.00	21.00
Chicago	62.25	66.40	91.30	.....	.....	.....	9.20	10.20	18.00	18.00	16.00
Cincinnati	44.25	53.80	98.00	113.20	149.10	169.40	11.00	13.50	15.20	11.20	.....
Cleveland	45.00	48.00	90.00	117.00	136.50	156.00	16.00	16.00	18.00	16.00	2.60§
Dallas	82.75	90.00	163.50	196.00	195.75	233.00	.....	15.50	20.00	19.00	2.50§
Denver	75.00	80.00	135.00	135.00	185.00	220.00	11.75	25.50	18.00	16.00	2.60§
Detroit	60.00	64.00	120.00	170.00	200.00	250.00	11.50	12.50	20.00	20.00	16.00
Kansas City	62.50	75.00	140.50	155.00	.....	.....	13.50	18.00	.55‡	.50‡	2.50§
Los Angeles	77.50	94.25	134.00*	188.00	232.50	311.50	11.50	.....	18.70	.....	19.70
Minneapolis	77.00	84.00	143.00	165.00	173.00	240.00	11.00	18.00	25.50	21.00	21.00
Montreal	.....	110.00	.....	.....	260.00	.....	19.00	32.00	23.00	13.00	16.00
New Orleans	58.40	62.30	116.90	159.20	194.69	.....	13.00	.....	25.00	12.50	1.95§
New York	81.00	86.00	129.00	193.30†	238.80†	295.60†	12.75	.....	19.00	15.00	20.00
Philadelphia	78.00	85.00	160.00	195.00	235.00	295.00	15.00	18.00	14.85	11.15	10.65
Pittsburgh	44.00	48.00	95.00	106.00	118.00	143.00	15.00	20.00	16.25	15.25	17.20
St. Louis	57.00	60.00	110.00	130.00	150.00	190.00	14.00	16.00	.55‡	.45‡	2.40§
San Francisco	68.00	76.50	174.00	.....	.....	.....	14.00	16.00	22.50	19.00	15.50
Seattle	80.00	87.00	200.00	.....	.....	.....	14.00	16.00	30.00	25.00	3.00§

*6x12x12 in. †F.o.b. Perth Amboy, N. J. ‡Per sack. §Per bbl.

ROAD SURFACING MATERIALS

	PAVING BRICK AND BLOCKS — Granite per M, lots of 50,000, 4x8x4 in., f.o.b. city	Brick per M, 3x8½x4 in., carload lots f.o.b. city	Wood per sq.yd., 3½ in., 16-lb. treat, f.o.b. city	PAVING ASPHALT — Per ton, less than 80 penetration, f.o.b. city: Tank car	Drums	ASPHALT BINDERS—FLUXES — Per gal., 80-300 penetration, f.o.b. city: Tank car	Drums	CUTBACK ASPHALT — Per ton, f.o.b. city: Tank car	Drums	ROAD OILS — Per gal., f.o.b. city: Tank car	ASPHALT EMULSION — Per gal., f.o.b. city: Tank car	Drums
Atlanta	$3.00*	$35.00	$2.25	$18.00	$23.00	$0.0733	$0.1028	$0.082†	$0.116†	$0.0728	$0.105	$0.105
Baltimore	140.00	43.00	2.25	17.00	22.00	.07	.095	.08†	.115†	.065	.....	.....
Birmingham	65.00	24.00	.....	18.00	23.00	0.0733	.1028	.082†	.116†	.....	.06	.....
Boston	77.50	32.00	2.25	18.00	23.00	.075	.10	.085†	.11†	.065	.09	.125
Chicago	145.00	42.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Cincinnati	115.00	37.00	.....	17.00	21.00	.09	.....	18.00	.....	.07	.08	.11
Cleveland	125.00‡	37.50	.....	16.00	18.50	.0948	.1448	15.00	21.00	.02	.08	.11
Dallas	.....	25.50	.....	16.45	21.10	.0584	.0809	19.60	25.00	.0484	.1384	.1684
Detroit	.....	35.50	.....	14.29	16.88	.....	.....	13.94	17.94	.....	.....	.....
Kansas City	.....	32.00	2.75	14.00	20.00	.06	.10	.08	.12	.06	.07	.09
Los Angeles	.....	48.50	.....	12.00	16.00	12.00#	16.00#	14.00	.....	.042	.0525	.1125
Minneapolis	.....	.....	2.50	17.30	21.30	.065	.105	19.60	32.20	.048	.....	.....
Montreal	.....	100.00	.....	14.00	19.66	.07	.093	19.00	26.50	.07	.125	.155
New Orleans	200.00	35.00	.....	13.00	18.00	.065	.09	.07†	.10†	.....	.....	.....
New York	135.00	47.50	2.05	17.00	22.00	.07	.095	.08†	.115†	.065	.085	.12
Philadelphia	115.00	45.00	2.02	11.00	17.00	.....	.....	.....	.....	.....	.....	.....
Pittsburgh	115.00	35.00	.....	19.00	24.00	.0775	.1125	.086†	.121†	.0675	.....	.....
St. Louis	2.75*	35.00	2.00	19.50	24.50	.08	.11	21.00	29.00	.04	.09	.125
San Francisco	.....	45.00	.....	12.00	18.00	12.00#	18.00#	14.00#	21.50#	.04	.08	.12
Seattle	.....	47.50	.....	18.00	23.10	18.00	23.10	15.00	.....	.02	19.20#	34.20#

Note: Paving asphalt, tank car or boat, f.o.b. Maurer, N. J., per ton, Bermudes, $25.00; Trinidad, $21.00. *Per sq. yd. †Per gallon. ‡4½x6x5½in #Per ton

CURRENT PRICES OF CONSTRUCTION MATERIALS

IRON AND STEEL PRODUCTS—BASE MILL PRICES

	STRUCT. SHAPES-PLATE Per 100 lb., carload lots	REINF. BARS Per 100 lb., ¾-in. billet, carload lots	RIVETS Per 100 lb., ½-in. structural carload lots	WIRE NAILS Per 100 lb., base, carload lots	SHEET PILING Per 100 lb., base, carload lots	STEEL RAILS Per Gross Ton			TRACK SUPPLIES Per 100 lb., carload lots			
						Standard	Light	Re-rolled	Angle bars	Std. spikes	Tie plates	Track bolts
Birmingham	$1.85	$1.95	.....	$2.35	.....	$36.375	$32.00	$31.00	$2.55	$2.40	$1.90	$3.55
Chicago	1.75	1.95	$2.85	2.35	$2.10	36.375	32.00	31.00	2.55	2.40	1.90	3.55
Pittsburgh	1.70	1.90	2.75	2.35	2.00	36.375	32.00	31.00	2.55	2.40	1.90	3.55

IRON AND STEEL PRODUCTS—LOCAL PRICES F.O.B. WAREHOUSE

	STRUCTURAL SHAPES Per 100 lb., base price	REINFORCING BARS Per 100 lb., ¾ in., base price		EXPANDED METAL LATH Per 100 sq.yd., carload lots		WELDED FABRIC REINFORCING Per 100 s.f., carload lots			SHEET PILING Per 100 lb. base price
		New billet	Rail steel	Std. diamond mesh, 3.4 lb.	Std. ribbed 3.4 lb.	4x16 in., No. 5 & 10 wires	4x12 in., No. 8 & 12 wires	6x6 in., No. 6 & 6 wires Per sq.yd.	
Atlanta	$3.34	$2.17	$2.02	$19.50	$22.00	$1.60	$1.21	$0.151	$2.45
Baltimore	2.85	2.60	2.40	22.00	24.00	1.46	1.12	.137	2.40
Boston	3.42	2.73	2.35	20.25	24.25	1.50	1.14	.142	2.40
Chicago	3.60	2.43	.....	20.50	24.00	1.46	1.12	.137	2.00
Cincinnati	3.30	3.10	3.10	20.50	23.50	1.44	1.11	.135	.....
Cleveland	2.90	2.90	2.45	15.40	17.40	1.44	1.11	.135	.....
Dallas	3.85	3.60	3.50	27.75	32.50	1.73	1.27	.161	.....
Denver	3.29	3.54	.....	23.00	27.00	1.70	1.27	.161	.....
Detroit	3.30	3.00	2.85	15.00	19.00	1.48	1.13	.139	2.885
Kansas City	3.75	2.82	2.63	19.00	.....	1.54	1.17	.145	2.60
Los Angeles	2.95	2.80	.....	25.00	30.00	1.90	1.40	.18	2.50
Minneapolis	3.35†	2.67†	2.52†	20.50†	24.00†	1.58	1.20	.149	2.40†
Montreal	3.25	3.00	2.80	.....	.....	.....	.....	.....	3.30
New Orleans	3.50	3.00	.....	19.50	23.00	1.58	1.20	.149	.....
New York	3.27	2.495	2.345	20.50	24.00	1.54	1.17	.139	.....
Philadelphia	2.60	3.00	.....	18.50	22.00	1.44	1.11	.135	2.28
Pittsburgh	1.70‡	1.80‡	1.75‡	17.00‡	22.00‡	1.44	1.11	.135	2.00‡
San Francisco	3.25	3.15	2.95	21.50	24.50	1.90	1.40	.18	2.40
Seattle	3.40	3.50	.....	.....	.....	1.90	1.40	.18	.....
St. Louis	3.34	2.29	2.14	24.80	28.00	1.46	1.12	.137	.....

†F.O.B. City. ‡Base Mill Price. Note: Shapes, bars and piling subject to quantity discounts.

PAINTS AND ROOFING SUPPLIES

	WHITE LEAD Per 100 lb. keg in oil, f.o.b.	READY-MIXED PAINT Per gal., drums, f.o.b.			ROOFING SUPPLIES Carload lots, f.o.b. city				
		Graphite*	Aluminum†	Ferric Oxide‡	Rolls, slate surfaced, 85-90 lb., per sq.	Asphalt felt, per 100 lb.	Tar felt, per 100 lb.	Asphalt coating, per gal.	Tar pitch, 350-lb. bbl., per ton
Atlanta	$11.50	$1.60	$1.10	.....	$1.94	$3.02	$3.30	$0.37	$22.80
Baltimore	11.00	1.25	2.25	$2.00	1.90	2.60	2.50	.50	27.00
Boston	11.50	1.05	1.80	1.50	1.875	2.625	2.625	.485	23.00
Chicago	11.00	1.85	2.25	1.25	1.60	1.50§	1.50§	.24	20.00
Cincinnati	11.00	1.40	3.00	1.55	2.40	2.25§	2.25§	.36	25.00
Cleveland	11.00	1.65	2.35	.....	1.65	47.50°	47.50°	.33	19.50
Dallas	12.00	1.90	2.10	1.50	2.17	1.98§	2.08§	1.55§	33.00
Denver	11.75	.....	2.55	.....	2.75	3.46	3.46	.60	30.00
Detroit	11.00	1.55	2.35	1.30	1.60	2.35	2.50	.40	27.00
Kansas City	11.12½	1.50	2.10	1.35	1.75	1.85	2.15	.30	26.50
Los Angeles	10.75	1.60	2.25	2.30	2.00	1.50	.....	.45	.....
Minneapolis	11.13	.....	.....	.....	1.60	1.50	1.50	.2925	23.30
Montreal	9.75	1.70	3.45	1.65	.....	2.62	2.02	1.40§	1.63§
New York	11.00	1.70	2.25	1.42	.....	.....	.....	.....	.....
Philadelphia	11.00	.....	.....	.....	1.60	1.50	1.50§	.29	20.00
Pittsburgh	11.00	1.05	1.95	.80	1.90	1.65*	1.65	.31	23.00
St. Louis	11.00	1.85	2.25	1.25	1.88	2.73	2.73	.44	26.00
San Francisco	10.75	.....	.....	.....	.....	.....	.....	.45	.....
Seattle	10.75	.....	1.92	.....	3.10	4.50	.....	.54	27.60

*New Jersey State Hwy. Spec. 120M. †ASTM Spec. D266-31. ‡80% maximum ferric oxide. °Per ton. §Per 100 lb. *Per roll.
Note: Red lead dry, same as white lead in oil, red lead in oil 50c higher.

MISCELLANEOUS ITEMS

WINDOW GLASS

Discounts from latest jobbers list, Sept. 15, 1928

	Single or Double Thickness	
	A quality	B quality
Atlanta	85%	85%
Baltimore	88%	90%
Birmingham	89%	91%
Boston	88%	90%
Chicago	87%	89%
Cincinnati	.....	.....
Cleveland	80%	83%
Dallas	.....	.....
Denver	84@ 5%	86@ 5%
Detroit	87@10%	89@10%
Kansas City	89@10%	89@10%
Los Angeles	90%*	90@40%*
Minneapolis	84%	86%
Montreal	.....	.....
New Orleans	87@10%	96@10%
New York	87%	89%
Philadelphia	88@10%	90@10%
Pittsburgh	86%	88%
St. Louis	87%	89%
San Francisco	90%	90@30%
Seattle	90@10%	90@20%

*Disc. from list Aug. 1, 1929. †F.o.b. Arsenal.

EXPLOSIVES

Per lb. dynamite delivered 50-lb. cases

	Gelatin	
	40%	60%
Atlanta	$0.215	$0.2375
Baltimore	.19	.20
Birmingham	.15	.1725
Boston	.2225	.2375
Chicago	.17	.195
Cincinnati	.22	.245
Cleveland	.1825	.1975
Dallas	.30	.35
Denver	.19	.205
Detroit	.237	.255
Kansas City	.16	.18
Los Angeles	.1725†	.1925†
Minneapolis	.1725	.1875
Montreal	.1875	.2125
New Orleans	.19	.22
New York	.23	.245
Philadelphia	.215	.24
Pittsburgh	.1175	.1325
St. Louis	.1375	.1525
San Francisco	.1575	.1725
Seattle	.1525	.1675

CHEMICALS

Water, sewage treatment, road work, f.o.b., carlots, New York:	
Bleaching powder, in drums, f.o.b. works, per 100 lb.	$1.90
Calcium chloride, 77-80%, flaked, in 400-lb. drums or 100-lb. moisture proof bags, f.o.b. works, freight equalized with points of competition, per ton	19.50
Chlorine, cylinders, per lb. delivered	.05½
Silicate of soda, 60 deg., in drums, f.o.b. works, per 100 lb.	1.65
Soda ash, 58%, in bags, per 100 lb.	1.25
Sulphate of aluminum, in 100 lb. bags per ton	27.50
Sulphate of copper, in bbl., per 100 lb.	3.75

PILES

Prices of Nichols Bros., 90 West St., N. Y. C., per linear foot, pine, with bark on, o.b., New York; delivered from barge, 1½ to 2c, per ft. additional:

Dimensions	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.09	$0.145
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.13	.195
12 in.—2 ft from butt	6 in.	60 to 69 ft.	.15	.215
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.185	.225
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.2025	.225
14 in.—2 ft. from butt	5 in.	80 to 85 ft.	.265	.375
14 in.—2 ft. from butt	5 in.	85 to 89 ft.	.305	.442

RAILWAY TIES

Prices f.o.b., per tie, for carload lots		6 In. x 8 In. by 8 Ft.	7 In. x 9 In. by 8½ Ft.
Boston	Oak, untreated	$0.90	$1.20
	Pine, untreated	.90	1.20
	Pine, creosoted	1.35	1.85
New York	Long-leaf sap pine, untreated	.80	1.00
	Mixed oak, untreated	.....	1.00
Birmingham	White oak, untreated	.75	1.50
	White oak, creosoted	1.40	1.45
	Southern pine, untreated	.35	.60
	Southern pine, creosoted	.95	1.35
Chicago	White oak, untreated	1.15	1.45
	Oak, empty cell, creosoted	1.50	1.85
	Oak, zinc treated	1.40	1.70
	Southern pine, creosoted	1.35	1.58
Los Angeles	Fir, untreated	.64	.89
	Fir, creosoted	1.84	2.59
Philadelphia	Red oak, untreated	1.00	1.20
	Red oak, creosoted	1.50	1.85
	White oak, untreated	1.10	1.55
St. Louis	Red oak, untreated	1.00	1.45
	Red oak, creosoted	1.40	1.95
San Francisco	Sap Pine or cypress, untreated	.90	1.25
	Douglas fir, green, untreated	.45	.63
	Douglas fir, empty cell, creosoted	1.14	1.56
Montreal	Birch or maple, untreated	1.00	1.00
	Birch or maple, creosoted	1.25	1.55

CURRENT PRICES OF CONSTRUCTION MATERIALS

WATER, SEWER AND DRAIN PIPE

	C. I. PIPE Per net ton, f.o.b. 6 in. and over b. & s. class B and heavier, C/L lots*	VITRIFIED SEWER PIPE Per foot, delivered, standard 8 in., s.s.	12 in., s.s.	24 in., d.s.	36 in., d.s.	CLAY DRAIN TILE Per 1,000 ft., carload lots, f.o.b. 6 in.	8 in.	CONC. SEWER PIPE Per ft., delivered; ASTM Spec. C 14-24 12 in.	24 in.	WROUGHT STEEL PIPE Full std. weight. Discounts from standard list for delivery from warehouse, except Pittsburgh prices are f.o.b. mill. Base price $200 per net ton. List prices per ft.: ¼ in., 9c.; ⅜ in., 12c.; 1 in., 17½c.; 2 in., 37½c.; 2½ in., 59c.; 3 in., 77c.; 4 in., $1.10; 6 in., $1.94. 1 to 3 in., Butt Weld Black	Galv.	2½ to 6 in., Lap Weld Black	Galv.
Atlanta	$40.00	$0.225	$0.405	$1.4625	$3.25	$80.00	$128.00	$0.625	$1.625	52%	44.5%	50%	42%
Baltimore	43.50	.40	.60	2.75	5.00	95.00	175.00	.75	2.00	....	....	....	....
Birmingham	36.00	.25	.45	1.625	5.00	85.00	.....	.....	.....	.....	.....	.....	.....
Boston	45.50	.294	.567	1.89	5.8425	68.25	101.00	.432	1.935	55.59%	44.83%	56.85%	46.10%
Chicago	44.00	.35	.675	2.25	5.125	120.00	200.00	.675	2.25	....	....	....	....
Cincinnati	43.00	.224	.432	1.71	5.2275	90.00	.....	.38	1.30	57.33%	46.31%	58.55%	47.53%
Cleveland	44.50	.203	.3915	1.755	5.6375	42.50	88.50	.536	2.102	59.4%	48.4%	60.6%	49.6%
Dallas	48.00	.3325	.465	.....	.....	99.00	.....	.60	2.27	....	....	....	....
Denver	56.00	.23‡	.415‡	1.73‡	.....	100.50‡	.....	....	....	....	....	....	....
Detroit	44.50	.28	.54	2.25	5.125	100.00	150.00	.....	.....	....	....	....	....
Kansas City	46.00	.33	.52	1.90	3.85	120.00	180.00	.....	.....	....	....	....	....
Los Angeles	44.50	.2825‡	.508‡	2.03‡	5.535‡	115.50	192.50	1.00	2.00	....	....	....	....
Minneapolis	46.50	.24‡	.432‡	1.728‡	4.35‡	65.00	120.00	.....	.....	....	....	....	....
Montreal	.....	.....	1.02	3.64	.....	.....	.....	.....	.....	....	....	....	....
New Orleans	42.00	.28	.392	1.90	.....	45.00	.....	.45	1.65	....	....	....	....
New York	43.00	.35	.675	2.83	7.48	.....	.....	.55	2.00	56.164%	45.144%	57.389%†	46.368%†
Philadelphia	41.50	.28	.54	1.80	.....	135.00	210.00	.....	.....	56.65%	45.63%	57.88%	46.86%
Pittsburgh	46.00	.175‡	.3375‡	1.53‡	4.8175‡	46.00	82.00	.75	1.75	67.5%	58.5%	68.5%†	59.5%†
St. Louis	43.00	.27	.486	1.944	3.96	85.00	195.00	.90	2.28	55.796%	44.76%	57.021%	46.0%
San Francisco	44.00	.25	.45	1.80	4.50	112.00	170.00	.....	.....	60.1%	52.4%	62.4%	53.1%
Seattle	45.50	.35	.63	2.52	.....	84.00	200.00	.50	1.60	60.3%	51.3%	63.3%	52.3%
Burlington, N.J. (base)	40.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

*Gas pipe and class A, $3 per ton additional, 4-in., $3 per ton additional. †3½ to 6 in. ‡f.o.b.

LUMBER AND TIMBER

		SHORT LEAF YELLOW PINE AND DOUGLAS FIR Per M ft. b.m., carload lots f.o.b. All S. L. Y. P. is No. 2 common or better and for No. 1 N. C. Box. All Fir planks No. 2 common; Fir timber is No. 1 common. Lengths up to 20 ft. 1x6, S4S	1x8, S4S	2x4, S4S	2x6, S4S	2x8, S4S	2x10 S4S	3x12 Rgh	6x12 Rgh.	12x12, Rgh.	LONG LEAF Y. P. Per M ft. b.m., C/L lots, f.o.b., merchantable grade up to 20 ft. 2x12, Rgh.	12x12, Rgh.
Atlanta	Southern Pine	$20.00	$21.00	$23.00	$20.00	$21.50	$22.00	$30.00	.....	.....	40.00	$45.00
Baltimore	Southern Pine	26.00	27.50	30.00	28.00	29.00	31.00	40.00	.....	.....	60.00	58.00
	Douglas Fir	28.50	29.50	32.00	31.00	32.00	33.00	33.50	$32.50	$32.50	.....	.....
Birmingham	Southern Pine	30.00	30.00	33.00	33.00	33.00	35.00	60.00	.....	55.00	42.00	60.00
Boston	Southern Pine	32.00	33.00	40.00†	40.00†	60.00‡	65.00‡	70.00‡	.....	.....	70.00	70.00
	Douglas Fir	31.00	31.00	40.00	40.00	42.00	43.00	42.00	42.00	42.00	.....	.....
Chicago	Southern Pine	34.00	35.00	33.00	32.	33.00	34.00	49.00	65.00	65.00	54.00	54.00
	Douglas Fir	40.00	42.00	40.00	40.00	40.00	42.00	50.00	50.00	50.00	.....	.....
Cincinnati	Southern Pine	32.00	32.00	32.00	31.00	31.00	34.00	40.00	.....	.....	.....	.....
	Douglas Fir	.....	.....	.....	.....	.....	.....	47.50	47.50	50.00	.....	.....
Cleveland	Southern Pine	30.50	31.50	37.50	35.50	36.50	38.00	46.75	.....	.....	36.75	56.75
	Douglas Fir	.....	.....	36.75	.....	.....	.....	.....	44.25	.....	.....	.....
Dallas	Southern Pine	30.00	31.00	32.50	28.60	31.25	32.75	42.50	.....	.....	45.25	40.70
	Douglas Fir	.....	.....	35.00	33.25	33.25	33.50	41.50	46.00	46.00	.....	.....
Denver	Douglas Fir	40.00*	40.00*	40.00*	40.00*	40.00*	41.00*	51.00*	58.00*	.....	.....	.....
Detroit	Southern Pine	29.00	30.00	32.00	29.00	31.00	32.00	36.00	.....	.....	34.00	47.00
	Douglas Fir	.....	.....	.....	.....	.....	.....	44.00	45.00	47.00	.....	.....
Los Angeles	Douglas Fir	27.00	27.00	27.00	27.00	27.00	30.00	27.00	31.00	28.00	.....	.....
Minneapolis	Western Pine	47.00	47.00	41.00	41.00	41.00	39.00	47.50	.....	.....	.....	.....
	Douglas Fir	34.50	34.50	34.50	34.50	34.50	39.00	44.50	44.50	42.50	49.50	49.50
Montreal	Spruce	25.00	26.50	22.00	24.00	25.50	32.50	34.50	.....	.....	40.25	.....
	Douglas Fir	47.50	47.50	42.75	51.25	51.25	57.75	.....	.....	.....	.....	.....
New Orleans	Southern Pine	25.60	27.20	28.80	24.80	28.00	28.00	38.40	.....	.....	33.60	54.40
	Douglas Fir	28.00	30.00	31.00	28.00	31.00	31.00	31.00	.....	.....	.....	.....
New York	Southern Pine	33.00*	34.00*	35.00*	35.00*	35.00*	37.00*	36.00*	.....	.....	75.00*	75.00*
	Douglas Fir	.....	.....	38.00*	36.00*	37.00*	37.00*	36.00*	40.00*	40.00*	.....	.....
Philadelphia	Southern Pine	28.00	29.00	29.00	28.00	29.00	31.00	33.00	.....	.....	62.00	60.00
	Douglas Fir	.....	.....	34.00	33.00	33.00	34.00	35.00	52.00	32.00	.....	.....
Pittsburgh	Southern Pine	26.50	27.75	32.75	29.25	31.75	32.75	41.50	.....	.....	57.50	57.50
	Douglas Fir	33.50	34.50	34.50	33.50	34.00	34.25	46.25	46.25	46.25	.....	.....
St. Louis	Southern Pine	33.00*	36.00*	33.00*	32.00*	32.50*	41.00*	49.00*	.....	.....	55.00*	62.50*
	Douglas Fir	.....	.....	.....	.....	.....	.....	59.00*	59.00*	59.00*	.....	.....
San Francisco	Douglas Fir	28.00	28.00	28.00	28.00	28.00	30.00	29.00	31.00	31.00	.....	.....
Seattle	Douglas Fir	22.50	21.50	21.50	21.00	22.00	22.50	20.00	20.00	22.00	.....	.....

*Delivered. †Spruce. ‡Long-leafed Y. P.

CURRENT BUILDING AND CONSTRUCTION WAGE RATES PER HOUR

	Bricklayers	Carpenters	Structural Iron Workers	Hoisting Engineers	Plasterers	Common Labor Building	Common Labor Heavy Const
Atlanta	$0.75/1.125	$0.40/.90	$0.60/1.25	$0.60/1.25	$0.50/.75	$0.30/.40	$0.30/.40
Baltimore	1.10	1.10	1.10	1.10	1.10	.45	.45
Birmingham	1.00	1.00	1.00	1.125	1.00	.30	.30
Boston	.90/1.30	.70/1.17½	1.20	.90/1.17½	.90/1.62½	.40/.70	.40/.70
Cincinnati	1.27½	1.02½	1.20	1.07½	1.27½	.45	.40
Chicago	1.50	1.31¼	1.35	1.31¼	1.50	.82½	.82½
Cleveland	1.25	1.12½	1.25	1.125	1.25	.72	.72
Dallas	1.12½	1.00	1.00	1.00	1.25	.40	.40
Denver	.60/1.12½	.60/.87½	.60/.87½	.60/.87½	.....	.50	.50
Detroit	1.00/1.10	.75/1.25	1.00	.70/90	1.25	.50	.50
Kansas City	1.32½	1.12½	1.12½	1.12½	1.32½	.60/.70	.62½
Los Angeles	.90	.75	1.12½	.75	1.00	.50	.60
Minneapolis	.90/1.00	.75	.90	.75	.90	.40	.50
New Orleans	1.00	.75	1.00	1.00	1.25	30./.40	.30/.40
New York	1.65	1.40	1.65	1.65	1.50	.82½	.82½
Philadelphia	.75/1.00	.50/.75	1.00/1.15	.75/1.00	.75/1.00	.30/50	.30/.50
Pittsburgh	.50/1.00	.50/1.00	.50/1.00	50/1.00	.50/1.00	.35/.50	.33/.50
St. Louis	1.50	1.25	1.47	1.35/1.47	1.50	.78½	.35/.78½
San Francisco	1.12½	.90	1.20	1.00	1.10	.60	.60
Seattle	1.20	.90	1.10	1.00	1.20	.60	.60
Montreal	1.20	.55	.85	.85	.85	.30	.20

Skilled Ave: (Bricklayers, Carp., Ironworkers) $1.062. Common Ave. $0.5268